HOW WE LIVE

OR

THE HUMAN BODY

AND HOW TO TAKE CARE OF IT

HOW WE LIVE:

OR,

THE HUMAN BODY, AND HOW TO TAKE CARE OF IT.

AN ELEMENTARY COURSE IN ANATOMY, PHYSIOLOGY, AND HYGIENE.

BY

JAMES JOHONNOT

AND

EUGENE BOUTON, PH. D.

REVISED AND APPROVED BY

HENRY D. DIDAMA, M. D.,

PROFESSOR OF THE PRINCIPLES AND PRACTICE OF MEDICINE IN THE COLLEGE OF MEDICINE, SYRACUSE UNIVERSITY; EX-PRESIDENT OF THE MEDICAL SOCIETY OF THE STATE OF NEW YORK, AND OF THE NEW YORK STATE MEDICAL ASSOCIATION.

NEW YORK:

D. APPLETON AND COMPANY,

1, 3, AND 5 BOND STREET.

1887.

WHY AND HOW.

For a long time the conviction has been growing that there is a radical defect in an elementary course of study which admits technical grammar, but excludes physiology, and which makes more of the classifications of expression than of the thought to be expressed. The urgent need has long been felt of giving more attention to subjects pertaining to life, those that may be a guide to thrift, health, and happiness.

Legislative Action.

These convictions seem to have been shared by the law-makers of New York and several other States. The recent enactments making physiology a part of the course of instruction in the public schools are evidences of this conviction; and from every point of view the measures appear wise and beneficent.

If wisely carried out, this law must be productive of great good. The attention of pupils will be directed to the laws which govern their own being. The truths set forth will find lodgment in the brain, and in time they will find expression in daily practice. As a result, we may look for improvements in food, in dress, in ventilation, in habits, in hours

of work and recreation, and in everything that pertains to living.

Plan of the Book.

The manifest importance of the subject is the "why" of the book. The "how" remains to be considered.

The book is elementary, not a scientific treatise for advanced students. Beginning with obvious relations, its method is inductive, each new topic growing out of the one that precedes it. It aims to present the laws of life in such a practical and reasonable way that they will become a guide to living.

In the treatment of each topic, function is considered before structure. The first step is to show that, for purposes of life and growth, there is a need. Then, in answer to the query as to what is done to satisfy the need, a full description is given of the organs used and the methods employed. This properly subordinates structure to use, and shows the true relations of all the agencies of life.

The limitations set by the term "elementary" have forbidden minute details, abstruse discussions, and ultimate analyses. All these are left for the "High-School Physiology."

Hygienic Laws.

An endeavor has been made to present the relations of part to function in such a way that the hygienic law applicable to the case follows as a matter of course, and scarcely needs to be stated. A law derived in this way compels assent and com-

mands obedience; while one learned from the book is likely to remain in the mind as a mere formula.

Incentives to Study.

At the close of each chapter a list of questions is appended, not on the text, but rather on subjects which the text suggests. The answers to these questions will test the pupil's powers of inference, and will incite to careful observation and study in various directions. When the questions are not matters of mere inference, one at a time should be given out at the close of each recitation, so as to allow ample time for inquiry and study. The good which will come from a judicious use of these topics may be lost by a rigid demand for a specific answer in a specified time.

Alcohol and Narcotics.

The provision in the new laws in regard to alcohol and narcotics seems to be another wise and timely measure. It assumes that bad habits are largely due to ignorance. It would diminish the evils by removing the cause. It submits the solution of a great social problem to science. It espouses no theories, but demands the exact truth. It calls upon the teacher to furnish the weapons that shall conquer prejudice, and arm the inexperienced against temptation.

In this work, alcohol and narcotics, in their relations to life, are duly treated. Wherever they are found in the body, their effects upon organ and

function are fully described. These effects, on the whole, are seen to be so pernicious that a knowledge of them would seem to be an almost sufficient safeguard against evil example, which is continually inciting to evil habits.

The error of over-statement has, however, been carefully avoided. Assertion without reason weakens a cause. The facts are sufficient. A serious mistake is made when the suspicion is aroused that an effort is made to establish a case, rather than to ascertain and state the truth.

Practical Application.

This and all kindred works will be of little use if thought stops with the text. What is said is valuable only as it "wakes up mind," and leads to further study, and to the observance of hygienic laws in daily practices. The teacher who allows his pupils to sit in draughts, and pays no heed to ventilation and the arrangement of light, and who is careless in regard to his own diet, dress, and hours of sleep, will teach physiology to little purpose.

The pupils should be made to see, to study, and to experiment. The word should lead to work. Principles should direct practices. The understanding of conditions must precede conscious obedience to law, but obedience is the desired end. Full mental conception of the subject in its relations will, in time, yield fruit in the direction of more healthful bodies, more vigorous minds, and lives made richer by the accomplishment of good deeds.

WHAT AND WHERE.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER X.

CHAPTER XI.

HOW WE LIVE.

CHAPTER I.

THE BODY AND ITS PARTS.

Why we should Study our Bodies.

WHEN we look at our bodies, we see that they are made up of parts. Each of these parts has a name and one or more uses. We know the most common of these names and uses; but, unless we have studied them with care, there are many important and interesting things about them that we do not know.

If any one should ask us the name of the highest part of the body when standing erect, we would answer that it is the head. We could also tell the names and the uses of the outer parts of the head. Perhaps we could make pictures of them.

We would, likewise, be able to tell that the part of the body next below the head is the neck; that the largest part of the body is the trunk; that the parts attached to the upper portion of the trunk are the arms; and that those attached to the lower portion of it are the legs.

But, if some one should ask us about what is inside of the head, neck, or trunk, we would be un-

able to answer from observation, and we could not tell either the names or the uses of the parts. Yet each of these inside organs has a work to do in the support of life; and the peculiar work which each does and its curious way of doing it are matters of great interest.

When a bee stings us, or we burn our fingers, we can tell the cause of the pain; and we shall be careful to avoid it in the future. But when we have earache or headache, we can not always tell the cause. By the study of those parts of the body which we can not see, we may so change our course of conduct as to avoid many aches and diseases.

If we see a person's tooth broken off, or his eye blinded by some accident, we shall never knowingly expose ourselves to the same danger; yet, by want of knowledge, we may neglect or abuse our teeth or eyes in such a way that they will be as surely destroyed as by a visible accident.

Most of the internal organs are soft and delicate; and when once injured they are afterward, in many cases, weak and nearly useless. By knowing what care they need, we may avoid injuring them, and so escape pain and disease.

It is necessary, therefore, that we should know a great deal about the parts of the body. We should know not only their names and uses, but also what will make them stronger or weaker. Then we shall know how to preserve our health, and thus be able to keep ourselves in the best condition to do our work in the world.

Looks are important. We like to see good-

looking people. We should desire to look well, so that our appearance will please others. One of the most important elements of good looks is health. A sickly person loses that clearness of complexion, that sparkle of the eye, and that elasticity of step and vigor of motion which we all admire.

By keeping in health we also enjoy life much better. We suffer less from bodily pain; we see things more clearly, and succeed better in what we undertake; we can take care of ourselves, and thus avoid becoming a burden to our friends; and we are more ready to perform any duty that may present itself. Besides, we are more cheerful. We do not take gloomy views of life, and make ourselves generally disagreeable; and, while we are happier ourselves, we make others happier also.

About Parts of the Body.

The Arms.—We see that the arms form a pair, and are fastened sidewise to the trunk just below the neck. They extend in opposite directions, and end in hands, which continue in the same direction as the arms. The hands terminate in fingers, and the ends of the fingers are protected by nails.

The Legs.—The legs are joined to the lower part of the trunk and extend downward, ending in feet, which are at right angles to the legs. At one extremity the foot has a heel, and at the other it terminates in toes, which, like the fingers, are protected by nails.

The Limbs and Joints.—The arms and legs when taken together are called limbs. All the

limbs are attached to the body in such a way that they can move in every direction. The point of attachment is called a joint.

If we examine a leg of mutton, or the leg of a chicken, which we may have on the table at dinner, we find in each a bone with a round head fitting into another bone having a cup-like cavity. These bones form what is called the ball-and-socket joint.

FIG. 1.—Ball-and-socket joint of the hip.

Such a joint we have at the shoulders and the hips, where the arms and the legs are attached to the body. The sockets at the shoulders are not so deep as those at the hips, and this arrangement allows the arms much greater freedom of movement.

We see that a door is attached to the jamb in such a way that it can swing in only two directions, backward and forward. This kind of attachment is called a hinge. The arms at the elbows, and the legs at the knees, have only a forward and backward movement, and hence these joints are called hinge-joints.

The double or compound joints at the wrists and the ankles admit of a great variety of movements, and are made up of several small, rounded bones which move about each other. The knuckles

and the toe-joints, like those of the elbows and the knees, are hinge-joints.

The lower parts of the arms and legs have also a turning or twisting motion, so that we can turn our hands completely over and our feet in and out. This motion is brought about in the arm by an arrangement of two bones which extend through the lower part of the limb, and which turn about one another.

FIG. 2.—Hinge-joint of the elbow.

Parts of the Body in Pairs.—Besides the pairs of arms and of legs, we have two ears, two eyes, and two cheeks. If we examine closely, we shall see that the nose has two nostrils, and that the two sides of the mouth are alike in structure. This arrangement of the external parts of the body in pairs makes it double; so that, if it were divided by a line running down from the middle of the forehead, it would be in halves, each with the same parts turned in opposite directions.

The Bodies of other Animals.—If we examine other animals, we shall see the same general plan of structure—parts in pairs, and opposite sides alike. The parts of other animals correspond to parts of our own bodies in many respects, agreeing in number, position, and general use, but differing somewhat in form. Thus the cat and the dog have four limbs each: but their arms are fore-legs; their hands, paws; and their nails, claws.

The horse and the cow also have four limbs each; but, in the place of toes, the horse has a single hoof, and the cow a double one. The chicken's arms are wings; the bat's four limbs are connected by a thin, delicate skin, forming wings with which it can fly; the four limbs terminate in feet, two of them webbed for swimming; the fish's four limbs are fins; and nearly all the vertebrates are provided with the same number of limbs, showing a general plan in creation, or, as Agassiz expresses it, "a thought of God."

Uses of the Parts of the Body.—In each one of us the part that thinks, or the mind, is the most important. The mind in thinking makes direct use of the brain. The brain is in the head, and is protected by the skull.

Every time the mind thinks, a tiny part of the brain wears out and must be repaired. The materials for the repair come from the blood. Hence we must have a way of making blood. For this purpose we have a trunk; and this is large, so that it may contain everything necessary for the process.

To make blood, we must have food; and to get food, we have arms to reach out and take it, and legs to go in search of it. We thus see that all the parts are made expressly for the service of the mind; and that by their proper action alone can the mind be kept in good condition. One would think, then, that the mind, if it is sensible, would take good care of the body.

Something to Find Out.

1. Why should we try to look as well as we can?

2. What are some of the things necessary to good looks that we all can attend to?

3. Which of the ball-and-socket joints are most easily put out of joint? Why?

4. What kind of joint unites the thumb to the hand?

5. How many joints have the fingers? the toes?

6. How does the great-toe differ from the thumb?

7. How does the ankle differ from the wrist?

8. How do the cat's toes correspond in number to our fingers and toes?

9. How do the cat's fore-paws differ from our hands?

10. What joint in the dog's hind-legs corresponds to our hips? knees? ankles?

11. What bone in the cat's leg represents our heel?

12. On what part of the foot do we tread? On what part does the dog tread?

13. Explain what is meant by the term *digitigrade—plantigrade.*

14. Give two examples of digitigrade animals—of plantigrades.

15. To which of these classes does the horse belong? the cow? the sheep? the bear? the elephant?

16. Why are the bones of the skull made very strong?

17. What animals use their fore-paws to hold their food while eating?

18. How does the duck's foot differ from that of a chicken?

19. What do birds have in the place of mouth and nose?

20. In what way can we best avoid mistakes in taking care of the body?

NOTE.—At the latter end of the book, commencing on page 156, will be found a topical analysis for each general subject treated in the several chapters. These outline statements may be made of great value to teacher and pupil, as showing the relations of the topics and sub-topics to each other, and as affording a scientific basis for examinations and reviews.

CHAPTER II.

EATING, AND WHAT COMES OF IT.

Why we Eat.

EVERY motion that we make, and every thought that we think, destroys some of the minute cells of which the various parts of the body are composed. If this waste goes on without repair, the parts soon wear out, and the body dies. The process of repair is called nurture, and the elements of nurture are found in food.

Before the food can nurture the body, it must undergo many changes. It must be broken up; parts of it must be dissolved; different parts must be mixed with each other; and the useful parts must be separated from those which are worthless. The first step in this process is eating. We eat, then, that we may live. We eat, that every part of our bodies may be strengthened, and that we may be able to do our daily work.

What we Eat.

Upon our tables, for breakfast or dinner, we have meat, bread, potatoes, fish, fruit, and many other articles of food to eat; and water, milk, and

other liquids to drink.* We must take this food and drink at regular times, to satisfy the demands of appetite and the needs of the system.

As the body is composed of many different elements, the food and drink which we take must contain these elements. If we take no food, we starve; if we take food that lacks some needed element, after a time we starve just as certainly.

More of the elements which the body needs are found in some articles of food than in others. But, as no one food contains all kinds and sufficient quantities of needed elements, we are obliged to take a variety of foods—one kind furnishing the elements which the others lack.

Kinds of Food.—One of the most valuable of all the foods is the *gluten*, or sticky part, of flour. It contains all the elements which the body needs, but not all of them in sufficient quantity.† Nearly the same elements are found in the *albumen*, or white,

* The pupil should here enumerate the different kinds of food in common use, and find out all he can about each. For example: bread is made of wheat; the wheat grows in our fields; the grain is taken to the mill and ground; and the meal or flour is made into bread. This treatment of the subject serves to introduce both farming and manufacturing operations, and to show their relation to our needs.

Again, take rice, another common article of food. This grain does not grow in our fields, but is the product of a warm, lowland region. The description of its place and manner of growth serves to show the relations of food to geography, and to give a new and vital interest to that branch of study. In like manner, tea, coffee, sugar, salt, and many other articles may be made to serve a similar purpose

† Wheat, the most valuable of our grains, contains a large amount of gluten. Fine white flour contains little gluten, and, when we make bread of it, we lose the best part of the grain. The "new-process" flour retains the gluten, and makes excellent bread.

of eggs; in the *myosin*, which is the principal part of lean meat; in the *caseine*, or curds, of which cheese is made; and in the *fibrine* which constitutes the clot of the blood. These foods are known as *proteids*, or *albuminoids*.

Another substance of great value as food is the *starch* that forms a large part of the grains and other vegetable products. Starch does not, however, contain so many of the needed elements as gluten, and is therefore less valuable as food. The same elements in differing proportions are found in sugar and in the vegetable gums. These foods are known as *amyloids*.*

The third class of foods includes all oily substances, both animal and vegetable, and are known as *fats*. They are composed of the same elements as starch and sugar, but they so differ in form that they need a different treatment before they can nourish the body.†

Minerals form the fourth class of substances that may be ranked as foods. They include lime, soda, potash, iron, salt, and water. These are all found

* Starch forms a large part of all the grains. Potatoes contain but little besides starch and water. Peas and beans are more than half starch. Tapioca, sago, arrowroot, and rice are nearly all starch. Beets, turnips, and other garden vegetables are principally made up of starch, sugar, and water.

† All the kinds of food given above not only furnish the elements of nurture, but each helps to furnish the heat necessary for the well-being of the body. But, while the proteids are best for nurture, the sugars and the starches are also needed. The amyloids have great power of producing heat, but the fats have still greater. In the frozen regions of the extreme north, oil is one of the most necessary articles of diet.

in the body, and must be contained in the different articles of food. These substances, with the exception of salt, are found in sufficient quantities in meat, in fruit, and in vegetables.

Special Foods.—Of the vegetable foods, wheat-flour and oatmeal contain the greatest number of needed elements, and come the nearest to perfect foods. Corn-meal is rich in starch and fats, but has little gluten. Peas and beans have a large portion of vegetable caseine, a substance that resembles gluten, and they are ranked very high as foods. As they are not easily digested, however, they should be taken only in small quantities by those who have weak stomachs.*

Beef is the best of all the kinds of meat. Next to this comes mutton. Chicken and turkey have nearly the same elements, with the exception of the fats. Veal, lamb, and pork have less of the elements which the body needs, and are harder to digest. Eggs and milk are nearly perfect foods. Fish and oysters are among the best of foods. Clams, crabs, and lobsters are less easily digested.†

* Graham-flour, containing the whole of the wheat-grain, makes sweet and wholesome bread. Rolls made of this flour, by simply mixing the flour with water or milk, and then pouring the thin batter into a hot roll-pan, and baking in a hot oven, are among the best forms of bread that can be made. The garden vegetables generally are made up of starch and sugar and a large amount of water.

† Meats are best when broiled or roasted. They should be exposed to a hot fire at first, so that a crust may be formed on the outside to preserve the inside juices.

In making soups, the meat should be put in cold water, and brought very slowly to the boiling-point, so as to extract the juices.

Fruits are mostly made up of starch and sugar, but they also contain more of the mineral matter needed by the system than is found in most other foods. The acid of fruits is also an aid to digestion. Fruits are chiefly valued, however, for their agreeable flavors, which gently excite the digestive organs; and when taken in moderate quantities they are very wholesome.*

Mixed Foods.—Our study so far has shown us that no one substance is a perfect food, and therefore that a mixture of foods is necessary to secure all the needed elements. Experience has taught us the same lesson, and the custom is general of mixing foods in such a way that one will supply the needed elements which the others lack. Thus bread, rich in gluten, lacks starch or fat, and butter is added; potatoes, mostly starch, are eaten with meat, gravy, or butter.

How we Eat.

Mastication.—The first step toward reducing food to a condition in which it can nourish the

When milk produces an unpleasant effect upon the stomach, it should be mixed with a little lime-water.

Fish and oysters should not be eaten unless perfectly fresh.

* Strawberries, raspberries, blackberries, currants, cherries, peaches, apples, melons, and oranges are all excellent, and their moderate use, each in its season, will, many times, make the doctor's visit unnecessary, and save us from a course of medicine.

The pulpy substance of unripe fruits is often hard and tough, and the juice strong and sour. When fruits, in this condition, are eaten, they can not be digested, and both pulp and juice cause irritation and often inflammation of the digestive organs. Fruits are made wholesome by ripening and by cooking.

body is chewing, or *mastication.* The organs directly used in chewing are the teeth, the tongue, and the cheeks. The teeth grind the food. The tongue and the cheeks keep the food between the teeth so that it may be ground.

The Teeth.—If we examine the mouth of a cat or a dog, we discover four prominent teeth that are long and pointed. The other teeth, both front and back, are shorter and smaller. These sharp teeth can easily pierce soft substances, and seem to be of just the right shape for tearing flesh.

In the mouth of a squirrel or rabbit we find the prominent teeth, four in number, directly in front. These teeth are long; but, instead of being pointed, they have a sharp edge like a chisel, which fits them for cutting hard substances or gnawing.

If we look into the mouth of a horse, we find the prominent teeth broad and flat, the exact shape for grinding grain, or for breaking in pieces the soft stalks of plants.

In our own mouths we find teeth like those of the dog, the rabbit, and the horse; but they are all nearly alike in size. The four cutting teeth on each jaw in front are called *incisors;* the four pointed teeth, one on each side of each jaw, next back of the incisors, are called *canine* teeth, or *cuspids;* the eight teeth next to the cuspids are the *bicuspids;* and the twelve back teeth, six on each jaw, are *molars.*

The parts of the teeth that lie inside the bones of the jaw are the roots, and the part of each tooth that appears outside the gums is the crown. Usu-

ally, the molars of the upper jaw have three roots each, and those of the lower jaw have two. The cuspids and incisors have only one root each.

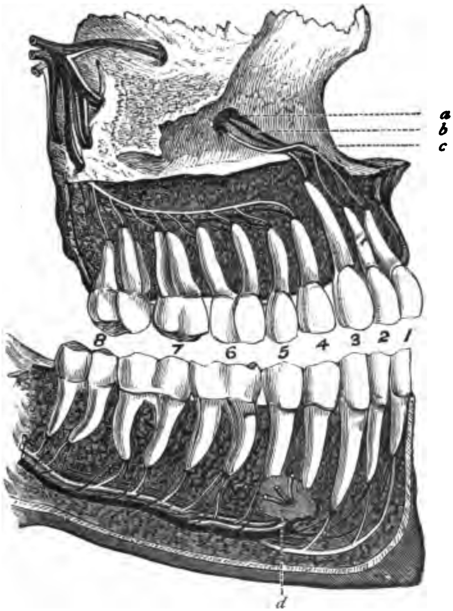

FIG. 3.—The jaws and the teeth: 1, 2, incisors; 3, canines; 4, 5, bicuspids; 6, 7, 8, molars; *a*, vein; *b*, artery; *c*, nerve; *d*, vein, artery, and nerve.

If we carefully examine a tooth, we find that the crown has a hard, smooth outside. This is called the *enamel*. Under the enamel is a softer kind of bone called *dentine*. In the middle of the tooth, and extending to the end of each root, is a cavity in the bone, through which extend a nerve and a net-work of blood-vessels.

Care of the Teeth.—When the enamel is broken the tooth decays, causing severe pain and an unpleasant breath. To prevent these troubles, the teeth should receive special and constant care.

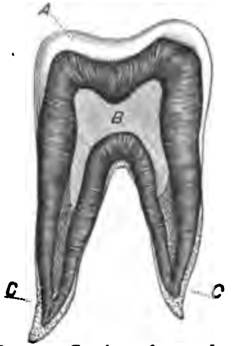

FIG. 4.—Section of a tooth: *A*, enamel; *B*, nerve cavity; *C*, *C*, roots.

Some boys try to crack hard nuts with their teeth, but crack the enamel instead, and so spoil their teeth. Biting hard substances of any kind has the same effect.

A pitcher when cold may be easily cracked by pouring into it a stream of hot water. The sudden and irregular change of temperature causes the break. In like manner the enamel of the teeth may be cracked by abruptly changing from cold to hot foods, as from ice-cream to hot tea.

When food gets lodged between the teeth and is permitted to remain there, a kind of gas is formed which destroys the enamel and causes the whole tooth to decay.

How to keep the Teeth Clean.—After each meal, the food lodged between the teeth should be carefully removed by a tooth-pick of wood or quill. The use of a pin or a penknife is apt to injure the teeth or the gums. On rising in the morning, after each meal, and before going to bed at night, the teeth should be cleaned with water and a tooth-brush.*

* The tooth-brush should be stiff enough to remove all food from the teeth, but not so stiff as to injure the gums.

A little fine salt may sometimes be used with profit. Powdered orris-root, used sparingly, will help to keep the breath sweet.

A hard substance, known as *tartar*, sometimes collects on the inside of the teeth, next the gums, and, if permitted to remain, will destroy both teeth and gums. When it begins to collect, this tartar may be readily removed by scraping the teeth with the broad end of a quill tooth-pick.

How we Swallow.

After the food has been chewed enough, it is to be swallowed. Before swallowing, *saliva* is mixed with it, moistening it, and making it slippery, so that it will go down easily. The saliva is furnished by the *salivary glands* of the mouth, and is obtained from the blood.

How Saliva Flows.—The salivary glands do not pour out saliva all the time, but are excited to action in various ways.

The movement of the jaws will produce a flow of saliva. In chewing, this flow is enough to moisten the food, and in talking it is usually sufficient to keep the mouth moist.

Touching any part of the mouth, or the presence of anything in it, will cause the saliva to flow, as every one knows who has been under the hands of the dentist.

The sight, smell, or taste of food when we are hungry will also "make the mouth water." This may be seen by watching a cow when she is looking on while her supper of turnips is in course of

preparation. The saliva is produced in such quantities as to flow out of the corners of her mouth.

Articles of a pungent taste, like mustard, pepper, horse-radish, and tobacco, make the mouth hot, causing a free flow of saliva.

Amount of Saliva.—We need just enough saliva to moisten our food. When we do not get enough, we find it difficult to swallow, and then there is trouble in the stomach. To get this amount takes time. Those who eat hastily, and bolt their food without chewing, may look forward to a time when they can not eat with any comfort, and when they will have no strength for work, or play, or enjoyment of any kind.

We need to eat slowly and chew our food very fine, so that the movement of the jaws will cause enough saliva to pour out. Bread and vegetable foods need more chewing than meats.

All flow of saliva in excess of the amount needed for the moistening of the food and the mouth is waste. The blood from which it comes is made thinner and poorer, and has less of the materials necessary for the repairs of the body.

How Saliva is Wasted.—If we keep our jaws in motion when we are not eating, a useless flow of saliva is produced, which is waste of material and weakening to the body. Chewing gum and all like habits are therefore hurtful.

Tobacco.—The most fruitful cause of waste in saliva, however, is the use of tobacco. The pungent qualities of this *narcotic* produce an excessive flow, and, when the exciting cause is constantly kept

up, the amount wasted often becomes serious and exhaustive.

Again, by this waste the materials of the blood by which saliva is furnished gradually diminish. The saliva itself becomes weak, inactive, and unable to perform its special work in the stomach; and, besides, other materials needed elsewhere are continually drained off.

One other effect of the use of tobacco needs to be mentioned here. It gives an unpleasant odor to the breath, and often causes a disagreeable habit of spitting; so that clean, sensitive, and refined persons do not like to have those who use tobacco come near them.

The Esophagus. — The *esophagus* is the tube through which the food passes from the mouth to the stomach. When the food is sufficiently chewed and moistened, it is pressed backward by the tongue, and falls into the *pharynx*, a portion of the throat which lies immediately above the esophagus.

On its way to the pharynx it passes over the entrance of the windpipe, but is kept from falling into it by the *epiglottis*, a valve which shuts down when the food comes along. Sometimes the epiglottis does not close quickly enough, and a particle of food, getting into the windpipe, chokes us, and causes us to cough until it is thrown out. By eating slowly we avoid this danger.

Muscles extend around the esophagus, and when the food enters from the pharynx they contract, the upper one first, and then the next in order, thus

gradually forcing the food into the stomach. The process of eating is now done, and that of digestion is ready to proceed.

Hygiene of Mastication.

From the foregoing study of the subject we derive the following laws in regard to mastication:

I. Take food that will best nourish the body.

II. Eat slowly, to give the time necessary for the proper action of all the organs of mastication.

III. Chew food until enough saliva is obtained to moisten it.

IV. Do not injure the teeth by biting hard substances.

V. Avoid exposing the teeth to sudden changes of temperature.

VI. Keep the teeth clean.

VII. Swallow slowly, so as to give the epiglottis time to act, and thus avoid choking.

VIII. Be sparing in the use of highly seasoned foods that induce too great a flow of saliva.

IX. Do not keep the jaws in motion by chewing gum and other substances not needed as food.

X. Avoid the use of tobacco, as it wastes saliva, weakens the body, and makes the person using it disagreeable.

Something to Find Out.

1. What other grains besides wheat are raised on our farms?
2. What garden vegetables do we raise to eat?
3. What part of the corn-plant do we eat? of the

potato-plant? of the beet? of the onion? of asparagus? of cabbage?

4. What substance in dough makes it stick together?

5. How is wheat-bread made light?

6. Why is it more difficult to make corn-bread light? In making corn-bread, what is the effect of mixing the white of eggs with the corn-meal?

7. Why is fat meat more eaten in winter than in summer?

8. How is the oil necessary for food obtained in the frozen regions?

9. Why is more wholesome food made from Graham-flour than from fine white flour?

10. Why is beef as a food better than pork?

11. Why are oysters better than clams?

12. Why is it better to roast beef than to boil it?

13. In boiling meats, should they be put into cold or hot water at first?

14. In what condition should oysters and fish be when used for food?

15. Of what benefit is the acid of fruits?

16. Why are green fruits unwholesome?

17. How may green fruits be made wholesome?

18. What kind of food should be mixed with the proteids? . What with the amyloids?

19. In cooking, what is usually mixed with macaroni? Why?

20. Mention other foods that are usually eaten together.

21. What are milk-teeth, and what care do they need?

22. When the permanent teeth show signs of decay, what should we do?

23. Why should we be sparing in the use of mustard and horse-radish?

24. When people know that the use of tobacco is hurtful, why do they not leave it off?

25. What is the best way to avoid the trouble of leaving off the use of tobacco?

26. What evils follow from eating too rapidly?

CHAPTER III.

HOW DIGESTION GOES ON.

To nourish the body, food taken into the stomach must be converted into blood. The process of preparing food to enter the blood, called digestion, takes place chiefly in the stomach and intestines.

Stomach Digestion.

Structure.—The *stomach* is a sack or bag in the lower cavity of the body, and holds from one to two quarts.* It has two openings. Through the up-

FIG. 5.—The stomach.

* The trunk has two cavities, the *chest* and the *abdomen*. These cavities are separated by a thick, muscular membrane, called the *dia-*

per opening, or *cardia*, the food comes in from the esophagus; and through the lower opening, or *pylorus*, the food, when in a proper condition, passes out into the intestines.

The stomach is made up of three coats. The outer, or serous, coat is strong and smooth. Its glossy surface is moistened by the *serum* from the blood, so that, when it rubs against the walls of the trunk, or against any of the other organs, there is no friction.

The middle coat is made up of muscles, which extend around the stomach in both the longest and shortest ways. These muscles contract and expand, giving motion to the stomach, and churning its contents.

The inner, or *mucous*, coat is soft, and lies in little ridges or folds, giving a great amount of surface. This coat secretes from the blood a fluid, known as the *gastric juice*, which flows in large quantities when the stomach is full. The churning process brings the gastric juice into contact with the food, and thoroughly mixes the contents of the stomach.

Food Changes.—The saliva, mixed with the food, is one of the agencies for changing the amyloids into grape-sugar—a process necessary to fit these substances to enter the blood.

The gastric juice dissolves the proteids, such as the albumen of eggs, the gluten of grain, and the fibrine of meat, and makes them fit to enter the blood.

phragm. **This membrane is attached to the walls of the trunk, and forms the floor of the chest and the roof of the abdomen.**

A small portion of the food is taken up from the stomach by capillaries, called *absorbents*, and carried at once to the portal vein. But by far the greater part is converted into a slimy, fluid mass, called *chyme*, and passes through the pylorus into the intestines.

Drink.—At each meal enough drink should be taken with the solid food to moisten the mass in the stomach. If too much is taken, the gastric juice is so diluted and weakened that it can not properly perform its work.

For the action of the mucous and muscular coats of the stomach, and of the absorbents, the animal heat must be kept up. By drinking ice-water, or any very cold drinks, with our meals, the heat is diminished, and the work of digestion goes on slowly, or not at all, until the heat is restored.

Alcohol in the Stomach.—When stimulants containing alcohol are taken into the stomach, the first effect is to excite the mucous coat, and increase the flow of the gastric juice. If the drink is continued from day to day, the gastric flow increases, and is excessive. In consequence, it becomes thin and weak, and is unable to perform its proper work of digestion.

But alcohol has a great power of absorbing water. It takes moisture out of the mucous coat of the stomach. By continually drinking it, the stomach becomes hardened, and is unable to supply gastric juice enough for digestion. If the drinking is then kept up, more or less active inflammation always sets in, often causing long illness, or death.

Alcohol has another peculiar effect. Its action on the stomach often leaves a sickly, sinking sensation, which can be relieved only by alcohol; and so drink induces drink, until the habit is formed from which no one can escape without great suffering.

While the alcohol is busy with its work in the stomach, the absorbents are trying to get rid of it. They take it up unchanged, and pass it on into the blood-vessels, ready to repeat elsewhere the mischief it has begun in the stomach.

Intestinal Digestion.

Structure.—The *intestines* are tubes lying in a coil, through which the food passes after leaving the stomach. The small intestine is about one inch in diameter and twenty feet long. The large intestine is twice as large, and five feet in length. This gives to the whole canal below the stomach a length of about twenty-five feet.

Like the stomach, the intestines have three coats, serous, muscular, and mucous. The mucous coat secretes from the blood and pours out in small quantities the *intestinal juices.* These mix with the chyme coming from the stomach, and convert into sugar a portion of the starch which has before escaped digestion.

The muscular coat of the intestines consists mostly of rings, and these, beginning with the one nearest the stomach, contract, one after the other, like those of the œsophagus. This action forces the contents downward, and finally expels the waste portion from the body.

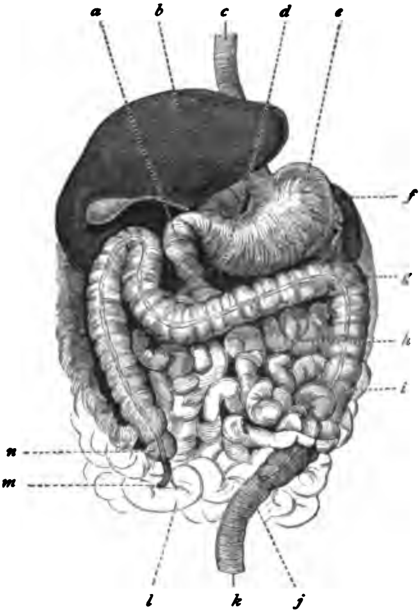

FIG. 6.—The organs of digestion : *a*, duodenum, leading out of the pylorus; *b*, liver; *c*, esophagus; *d*, pancreas; *e*, stomach; *f*, spleen; *g*, *i*, *j*, *k*, *m*, *n*, parts of large intestine; *h*, *l*, small intestine.

The Duodenum.—The upper part of the small intestine, about twelve finger-breadths in length, is called the *duodenum*. The chyme enters this canal from the stomach, and on its passage receives two fluids known as *pancreatic juice* and *bile*, and these still further prepare the food for the nurture of the body.

The Pancreas.—The *pancreas* is an organ lying back of the stomach, irregular in shape and about

six inches long.* It secretes pancreatic juice from the blood, and pours it out into the duodenum to mix with the chyme. The pancreatic juice is alkaline, and neutralizes acids. It also acts upon undigested amyloids, proteids, and fats.

When the chyme enters the duodenum, the oily portion lies on the surface. The pancreatic juice unites with it and divides it into minute particles and mixes it through the whole mass of chyme, as the oily particles of cream are divided and mixed in milk. A part of the oil is converted into a substance resembling soap.

The Liver.—The *liver* is a large organ lying on the right side under the lower ribs. It secretes bile from the blood and pours it out into the duodenum. The portion of the food taken up by the absorbents and carried to the veins passes through the liver. In the liver-cells a sugary substance called *glycogen* is secreted, and conveyed by the hepatic veins into the general circulation.

The office that bile has to perform is not fully understood. That it is waste matter which the blood must get rid of, is shown by the fact that, when resorption of the bile takes place, the body becomes yellow with *jaundice*. It is pretty well understood that the bile assists the pancreatic juice in reducing fats; that it supplies alkali to neutralize the acid of the chyme; and that it stimulates in the intestines a mucous secretion which lubricates them and renders the passage of waste matter easy.

* In animals whose flesh we eat, the pancreas is called *sweet-bread*, and is considered a great delicacy for the table.

Alcohol in the Liver.—The alcohol expelled from the stomach makes its next appearance in the liver, whither it is carried through the *portal vein.* Here, if continued from day to day, it also changes the tissue, so that the work of the liver is imperfectly done or suspended altogether. If the drink is then kept up, inflammation often sets in, causing much suffering and frequently ending in death. From the liver the alcohol passes unchanged into the veins.

Absorption.—By the action of the pancreatic juice, and the bile in the duodenum, the chyme is converted into a milky substance called *chyle*, and continues its way through the intestines. In its passage, the portions fit to make blood are taken up by the absorbents and *lacteals* and are carried to the veins.

The mucous coat of the stomach and the intestines is covered with a net-work of minute veins, and into these a portion of the food is carried directly. These veins all empty into the portal vein, which terminates in the liver. After a change effected by the liver, through the *hepatic veins*, this material is poured into the large vein ascending from the lower extremities.

The Lacteals.—All along the intestines are little absorbent tubes known as lacteals.* These unite in little groups and form larger tubes. These at last all terminate in a single tube, about the size

* It is estimated that these lacteals number about seven thousand in each square inch of surface, and that in the entire length of the intestines they number from three to five millions.

of a goose-quill, which lies in front of the spinal column, and is known as the *thoracic duct.*

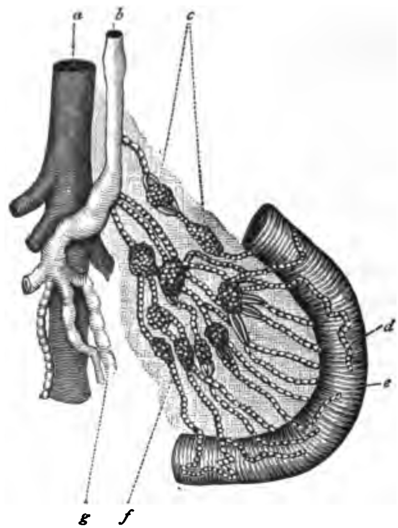

FIG. 7.—The lacteals and their connections: *a*, portal vein; *b*, *g*, thoracic duct; *c*, groups of lacteals; *d*, *e*, intestine; *f*, lacteals.

The greater part of the chyle is absorbed by the lacteals. It is carried to the thoracic duct.

Ascending through that tube, it is poured into a vein which lies under the left collar-bone, or clavicle, and is known as the *subclavian vein.* It now finds its way to the heart through the currents from the upper extremities.

Summary of Changes.—Food is masticated in the mouth by the teeth, and is mixed with saliva.

The amyloids are digested by the action of the saliva, the pancreatic juice, and the intestinal juices, and by a change effected in the liver.

The proteids are reduced, or dissolved, in the stomach by the gastric juice.

Acids are neutralized by the alkali of the bile.

Oily substances are reduced in the intestines by the action of the bile and the pancreatic juice.

These several changes complete digestion, and change food so that it readily enters the blood.

Hygiene of Digestion.

Like other parts of the body, the digestive organs need rest. If kept constantly in action, they become weary and unable to perform their proper work. From this fact, and from the lessons which have gone before, we derive the following hygienic laws:

I. Take food that can be digested.

II. The food should be so prepared as to digest most easily.

III. Enough food should be taken to nourish the body, and no more.*

IV. Food should be taken at regular times, with intervals between sufficient to give the digestive organs a chance to rest.†

*** The best guide to the proper kind and amount of food is a healthful appetite. As there is a pleasure in eating, however, there is danger of eating too much, especially if the food is taken rapidly. The appetite, too, may be spoiled by various indulgences, and then it ceases to be a guide. In such cases the only way we can determine what is best for us is by the study of the nature of foods, and by experience as to what seems to suit our own conditions best.**

† If children must eat candy and sweetmeats, the best time for them is directly after a meal, as the habit of eating between meals is very injurious. After a long process of digestion, the tiny digestive organs become tired, and it is wrong to overtax them. We ourselves

V. At meal-times, and until digestion in the stomach is nearly finished, water and other liquids should be taken sparingly.

VI. Avoid the use of tobacco, as it prevents the changes which should be made by the saliva.

VII. Avoid the use of alcoholic drink, because it prevents the changes which should be made by the gastric juice and by the liver.

VIII. Avoid all substances, like unripe fruits, that have a tendency to create disturbances in the intestines.

Something to Find Out.

1. What would be the effect if the serous coat of the stomach should become rough?
2. What would be the effect if the muscular coat should cease to act?
3. What effect has the gastric juice upon starch?
4. When the mouth is full of food, should we take drink to "wash it down"?
5. Why is it better to take drink toward the end of a meal than at the beginning?
6. What is the effect of taking ice-cream after a meal?
7. How do vinegar and sour fruit sometimes improve digestion?
8. Why are biscuits containing a large quantity of soda hurtful?
9. Under what circumstances may it be proper to take a little soda into the stomach?

need a rest after a hard task, and are discouraged, if, when our work seems to be done, more is given us to do. So it is with the little lacteals and absorbents. It is not fair to keep them constantly at work.

10. Should we take food "between meals"? Why?

11. Should we eat just before going to bed? Why?

12. What is the harm of eating when we are tired?

13. Should we engage in violent exercise just after a meal?

14. What is the best condition to be in for the half-hour before and after meals?

15. What are the best foods for invalids and persons with weak stomachs?

16. What is the general difference between a proper summer and winter diet?

17. How can we avoid the evil effects which tobacco causes in the stomach?

18. In what way is the habit of taking alcoholic drinks formed?

19. How can we avoid the suffering caused by breaking off such a habit?

20. Why do people begin the use of strong drink?

21. What is the effect of eating so much at a meal as to overload the stomach?

22. Mention some remedy for the evil of over-eating.

23. What is better than medicine to preserve a healthy digestion?

CHAPTER IV.

HOW THE BLOOD GETS PURIFIED.

THE newly made blood brought by the lacteals and absorbents is poured into veins, where it mingles with the currents returning to the heart. This blood is laden with materials which the body no longer needs, and before it can nurture the body it must be purified. For this purpose, it must come in contact with air, to which it may give off the waste matter it contains, and from which it may receive oxygen.

The Heart.

On its way to the air, the venous blood first enters the heart. This organ is placed in the chest between and partly behind the two lungs, and slightly on the left side. It is about as large as the fist, and is shaped somewhat like a pear. It points downward toward the front. It is made up entirely of strong muscular fiber, so that it can contract with very great force.* It is surrounded by

* It has been found that, during twenty-four hours, the average healthy human heart does an amount of work equivalent to raising 92.425 tons one foot high, or of raising one ton over 92 feet high. A

a smooth, satin-like membrane, called the ***pericardium.***

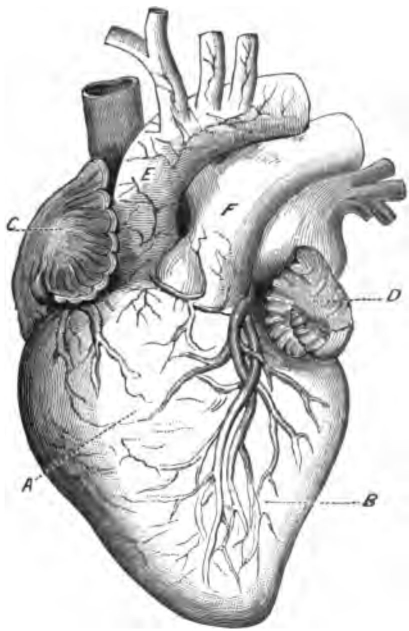

FIG. 8.—The heart and large blood-vessels: *A*, right ventricle; *B*, left ventricle; *C*, right auricle; *D*, left auricle; *E*, aorta; *F*, pulmonary artery.

The Plan of the Heart.—The heart, like many other parts of the body, has a double structure.

good climber can only raise his own weight 9,000 feet in nine hours, or 1,000 feet an hour; while the work done by the heart is equivalent to raising its own weight (ten ounces) 13,860 feet an hour. The most powerful engine ever made by man, the "Bavaria" locomotive of the Vienna and Trieste Railway, can only raise itself through 2,700 feet in an hour; that is, its energy is less than one fifth of that of the human heart.—("The Heart and its Function.")

Its right and left sides are entirely separated by an unbroken wall of muscle. In structure, the two sides are nearly alike, but each side has its own separate work to do. The right side, which receives the blood from the veins and sends it to the lungs to be purified, is sometimes called the *pulmonary* heart; and the left side, which receives the blood from the lungs and sends it out to nurture the system, is called the *systemic* heart.

Each side of the heart has two cavities, the smaller one being above, and the larger below. The upper cavities are called *auricles*, and the lower ones *ventricles*. As the blood flows from the veins into the auricles gently, the walls of the upper part of the heart are not so thick and strong as if they were intended to sustain a heavy strain.

From the ventricles the blood must be forced or driven, through the blood-vessels, and, in consequence, the muscular walls of the ventricles are thick and strong.

Between the auricles and ventricles are valves opening downward, which admit blood freely from above, but which close and prevent its return. The blood-vessel leading from the right ventricle to the lungs is called the *pulmonary artery*.

Pulmonary Action.—The currents from the veins, one from the upper extremities and one from the lower,* unite and empty into the right auricle of the heart. The walls of the auricle contract, and force the blood through the valve into the right

* The large vein from above is called the *superior vena cava*; and that from below, the *inferior vena cava*.

ventricle. The powerful muscular walls of the ventricle then contract, the valve shuts, and the blood is driven through the pulmonary artery to the lungs, where it comes in contact with the air.

The Lungs.

The *lungs* are in two divisions, occupying the right and left sides of the upper part of the chest.

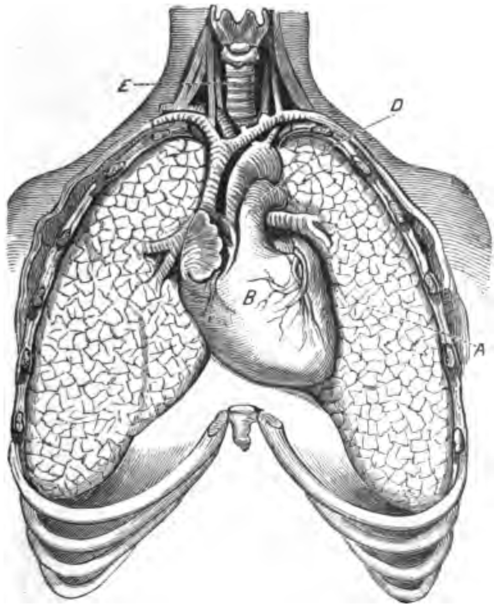

FIG. 9.—The cavity of the chest, showing the positions of the heart and the lungs: *A*, left lung; *B*, heart; *D*, pulmonary artery; *E*, trachea, or windpipe.

The right side has three distinct parts called *lobes*, the left has two.

Structure of the Lungs.—The lungs are made

up of soft, elastic tissue arranged in the form of minute cells. These cells are connected with small

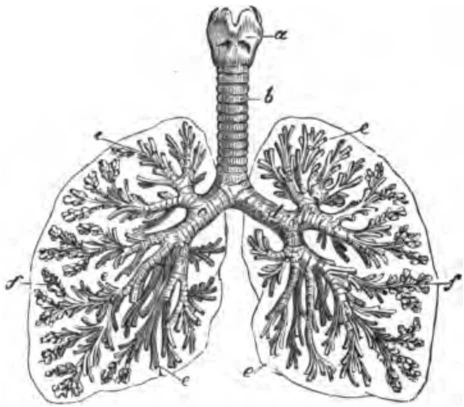

FIG. 10.—Air-passages in the human lungs: *a*, larynx; *b*, trachea; *c*, *d*, bronchi; *e*, bronchial tubes; *f*, clusters of air-cells.

passages, which open into larger ones, uniting in a single pipe. All these passages, small and great, are called *bronchial tubes*, or *bronchi;* and the pipe into which these open is the windpipe, or *trachea.* Lying next above the trachea is the *larynx*,* which opens directly into the throat, and through the nasal passages and the mouth into the air.

The pulmonary artery comes out of the right ventricle of the heart as a single tube; but it finally divides into five branches, one extending to each of the five lobes of the lungs.

Entering the lungs, these blood-vessels divide into minute passages, which extend to every part

* The larynx makes a lump in the neck which we can feel, and which is called "Adam's apple."

of the lungs, and surround every air-cell. Indeed, the lungs may be considered as made up of air-passages and blood-vessels, with just enough tissue to form the necessary cells and tubes.* The lungs are surrounded by a smooth membrane called the *pleura.*

How the Chest Varies.—The capacity of the chest varies with the breath, increasing as the breath comes in, and diminishing as it goes out. This change is effected by the movement of the ribs and the diaphragm. In the process of breathing, the respiratory muscles contract, and move the ribs outward and upward. At the same time, by the contraction of the muscles of the diaphragm, its arch is drawn down, and the cavity of the chest is made both broader and deeper.

When these muscles relax, the ribs droop downward, the diaphragm returns to its arched position, and the chest is narrowed and shortened.

Forces in Breathing.—Breathing is brought about by two forces—the pressure of the air, and the elastic force of the lung-tissue. When the ribs are elevated and the diaphragm is depressed, there is a tendency to produce a vacuum between the lungs and the walls of the chest. The air, pressing fifteen pounds to the square inch, forces its way into the air-passages of the lungs, and expands the lung-tissue so that it fills the enlarged space within the

* If two small trees with bushy tops were placed together in such a way that the branches and twigs of one were closely interlaced with the branches and twigs of the other, they would show how the divisions of the pulmonary artery and those of the air-passages are brought together in the lungs.

chest. This act, of breathing the air in, is called *inspiration.*

When the ribs and the diaphragm return to their passive condition, as the tendency to a vacuum no longer exists, the pressure of the air ceases, and the elastic tissue contracts, forcing the air out. This act of breathing out is called *expiration,* and the whole act of breathing is called *respiration.*

Action in the Lungs.—At every inspiration the air passes through the nose* or the mouth into the bronchials and finds its way into every little air-cell. The walls of these cells, separating them from the blood-vessels, are so thin that air and gas readily pass through. In this way the impure matter of the blood finds its way into the air-cells, and the oxygen of the air enters the blood-vessels.

Results of Breathing.—The air, which comes into the lungs pure, goes out laden with carbonic-acid gas† and other impurities. It is so foul that it is unfit to be breathed again.

The blood, which comes into the lungs laden with impurities, gives off waste matter, and re-

* The outer nasal passages are supplied with fine hairs, so that the air on its way to the lungs is filtered, and no dust is allowed to pass. The nose has also the sense of smell, and whenever it detects foul odors the air is unfit to breathe. The nose thus becomes a sentinel at the gate of the lungs. For these reasons we should always breathe through the nose instead of through the mouth.

† Carbonic-acid gas is one of the products of worn-out animal tissue. It is also produced by burning wood and coal, and in other ways. Air that contains much of it is unfit to breathe. It is, however, one of the principal supporters of vegetable life. Vegetation takes up carbonic acid and pours out the oxygen necessary to animals. The two great divisions of living things thus continually work for one another.

ceives life-giving oxygen. Its color is changed from a dark, dull red to a bright scarlet, and it is filled with the strength and health necessary to nurture the body.

Return of the Blood.—The blood, thus purified and strengthened, flows from the small passages of the pulmonary artery into similar small passages of the *pulmonary veins*. These small vessels open into larger ones, and finally they all unite, forming four principal tubes, two upon the right side and two upon the left, and pour the blood into the left auricle of the heart. The blood is now purified and ready to be sent out to nourish all the parts of the body.

Alcohol in the Lungs.—The alcohol which entered the veins from the liver makes its appearance in the lungs. As it does not become a part of the blood, or furnish it with any needed element, an effort is here made to get rid of it, and the effect is shown in the peculiar and disagreeable odor of the breath of habitual drinkers.

But the lungs have enough to do to relieve the blood of its waste matter. To get rid of the alcohol requires additional work, and this work, when excessive and continuous, wearies and weakens. After a long effort in trying to expel alcohol, the lungs become so feeble that they readily contract diseases such as pneumonia and consumption, and these diseases are much more rapid and violent when they take hold of weakened tissue.

If the amount of alcohol is large, the lungs can not get rid of the whole of it, and a portion enters the pulmonary veins and mingles with the currents

that circulate through the body. Here, as before, the alcohol is in the blood but not a part of it, and efforts are made to expel it wherever it appears.

Tobacco in the Lungs.—In smoking, the fumes of tobacco are frequently drawn into the lungs. This is especially the case in smoking cigarettes. The effect of the tobacco upon the lung-tissue is to retard its action, so that all the changes effected by breathing are more slowly performed. In this way the blood goes on in its course without being sufficiently purified, and is therefore unable to properly nourish the body. The first result is a feeling of languor and repose, and this, if repeated, often becomes torpor and stupidity.

Tobacco affects children most unfavorably before they have attained their full growth. The action of the organs necessary for growth and bodily activity is retarded, the body becomes feeble, and is often stunted. The mind is rendered as weak as the body, and many times it loses all power of effective study.

The Need of Pure Air.—We have already seen that the air once breathed is no longer pure. It is just as unfit for breathing again as muddy water is for drinking or decayed food for eating. But air is rendered impure in many other ways. From stagnant water and from decaying animal and vegetable substances, gases arise which make the air unfit for breathing. Whenever foul air is breathed, the blood is not fully purified, and the body is not properly nourished. Some of the most fatal diseases result from breathing air laden with foulness.

Hygiene of Respiration.

As air is a necessity of life, some of the rules that should guide us in regard to air become obvious:

I. When the nose detects an unpleasant odor, the air is foul, and we should avoid breathing it, if possible.

II. We should not breathe air that is made foul by our own breath, or by that of other persons.

III. We should not stay long in a crowded room, unless it is well ventilated.

IV. We ought not to sleep in small, ill-ventilated bedrooms.

V. Impurity of air in a room can be detected only when coming in from fresh air; hence extra care should be taken to thoroughly ventilate all occupied rooms every day.

VI. We ought to keep away from the vicinity of stagnant water.

VII. We should never permit decaying animal or vegetable matter to remain near our houses.

VIII. We should carefully avoid breathing the gas from sewers, sinks, and cess-pools.

IX. We should avoid alcohol, tobacco, and other articles that give extra foulness to the breath.

X. No article of dress should be worn so tight as to prevent the expansion of the chest in respiration.

XI. The weight of the clothes should hang from the shoulders, or be so distributed as not to be felt as a band about the ribs.

XII. We should never sit or stand in such a way

as to cramp the chest, and prevent full and free respiration.

Something to Find Out.

1. What parts of the body lie next to the heart?

2. Why is the pericardium, which incloses the heart, smooth on the outside?

3. What besides the smooth surface of this membrane prevents friction?

4. What kind of membrane forms the pleura, and what is its use?

5. What is the name of the disease to which the pleura is subject?

6. How may the lungs of a sheep or a calf, which we get from a butcher, be filled with air?

7. When these lungs are full, how is the air driven out?

8. About how much force is required to inflate our lungs?

9. Why is it more difficult to breathe on the top of a high mountain than at the bottom?

10. Why is it best to have a house "somewhat back from a village street"?

11. Why is it more healthful to travel after a rain than before?

12. What organ serves the lungs by giving warning of the presence of foul substances?

13. What should we do when we get a strong smell of carrion?

14. Why should we not take a pan of live coals into the bedroom which we occupy?

15. What shall we do when we detect the presence of carbonic-acid gas in our rooms?

16. In what way does foul air affect the pupils of a school?

17. How should the cellar of a house be kept?

18. What kind of sink in a kitchen is harmful?

19. What should be done with apple and potato parings, and the waste part of vegetables?

20. What is to be done with tainted meat?

21. Why should we particularly avoid taking the breath of persons who are ill?

22. When resting after violent exercise, what precaution should we take?

23. Why does tobacco affect children worse than it does grown people?

24. In what way can we avoid the weakening effect of alcohol on the lungs?

25. What is the best way to avoid the stupefying effect of tobacco in the lungs?

26. In building a school-house or a dwelling-house, why should we place it at a distance from a swamp?

27. Why will a person coming into a room from the out-door air detect impure air in a room, while the inmates are unconscious of the impurity?

28. In building halls, churches, and places of public resort, what matter needs special attention?

29. When the people at church or while attending a lecture become sleepy, what is probably the matter?

30. As the cost of ventilating a single school-room does not exceed twenty dollars, what excuse has the district for not providing means of ventilation?

CHAPTER V.

HOW THE BLOOD NURTURES THE BODY.

Waste and Repair.—Every time we take a step or raise an arm, portions of the muscles that move are used up. By every motion some part of the body is destroyed. Each action of the stomach, each heave of the breath, each beat of the heart, consumes tissue; and, indeed, it may be said that every part of the body is all the time wearing out.

But, during life, nurture also is always going on. Sharp little eyes are keeping watch over every part of the body, and nimble little fingers are busy in repairing and restoring. No sooner is one particle removed, than another takes its place. On one side of each tiny cell the invisible sexton is hurrying away matter which is dead; on the other, the unseen builder is filling the vacant space with matter which is living.

From birth to death these changes are going on. The agent that brings them about is the blood. The way in which the blood sets about its work is by circulation. The chief cause of circulation is the action of the heart.

The Arteries.—The channels leading out from the heart are called arteries. They are made of a

stiff, elastic material, so that they retain their shape when pressed upon, and regain it when stretched or bent. Like the stomach, they have three coats.

The great artery leading out of the left ventricle of the heart is the *aorta*. This main tube divides, sending large branches upward to the head and upper extremities, and downward to the lower extremities. These branches divide again and again, until they terminate in minute tubes distributed to every part of the body.

The Capillaries.—From the extremities of the small arteries a net-work of fine, hair-like tubes, called capillaries, extends through nearly all the tissues of the body. These tubes lie so close together that we can scarcely thrust the point of a fine needle into any part of the body without piercing some of them.

The Veins.—The capillaries, at the extremity opposite to the arteries, open into minute veins. These veins come together and form larger ones, until they all unite in two principal channels—the superior vena cava from the upper extremities, and the inferior vena cava from the lower. These two receive the blood and pour it into the right auricle of the heart. The walls of the veins are not stiff, like those of the arteries, but readily yield to pressure.

Action in the Heart.—As we have already seen, the purified blood from the pulmonary veins pours itself into the left auricle of the heart. The muscular walls of the auricle contract, and force the blood into the left ventricle. Then the walls of the ven-

tricle contract, the valve opening from the auricle shuts, and the blood is driven through the arteries into every part of the body.* To drive the blood so far and so rapidly requires a great amount of force, and therefore the walls of the left ventricle of the heart are very thick and strong.

Action in the Arteries.—The arteries are usually placed deep in the flesh, to be out of the way of harm. The blood is forced into them by jets at each heart-beat. Their elastic walls yield to the rush, but contract again, helping the blood along its course.† In this way the minute vessels are filled, and the beating or pulsation which began at the heart is carried on to the extremities, so that every part of the body is quivering with motion and life.

Action in the Capillaries.—From the extremities of the small arteries the blood enters the capillaries. In each the stream is very minute and flows at an even rate. Here nutrition takes place. Oxygen from the blood unites with particles of tissue,

* The average number of heart-beats in a minute is about seventy. The number is greater in children than in adults, and greater in women than in men. With the body in a standing position, the heart has not only to force the blood to all parts of the body, but has to lift it from the chest to the head, and from the feet to the chest. When we lie down, the heart is relieved from this necessity of lifting, and its action is diminished. The amount of blood which the heart moves is estimated at eighteen pounds per minute.

† At the wrist, and at some other parts of the body where the arteries come near the surface, we can feel the *pulse*. Each beat of the pulse is the yielding of the artery to a beat of the heart. One of the surest means by which the physician finds out the condition of the body is the beating of the pulse.

and burns them, causing both the heat and the motion of the body. The particles thus destroyed by use are taken up and carried away, and new particles full of life and strength are deposited in their place. In this way tissue is repaired, vigor is restored, health is kept up, and life is continued.

Action in the Veins.—The blood as it enters the veins from the capillaries is changed. The limpid current has become thick and turbid; the bright scarlet has deepened to a dark, dull red. The jets have ceased, and the current flows on smoothly and evenly. All along the courses of the veins, valves open toward the heart, so as to allow the blood to freely flow in that direction; but they shut, so as to prevent its return. In action, the muscles press upon the veins and hasten the flow; so that work, play, and exercise of every kind, help the blood along its course.* From the veins the blood flows, as we have seen, into the right auricle of the heart.

Alcohol in the Blood.—The alcohol which the lungs can not expel returns to the heart and enters the general circulation. Although never becoming a part of the blood, its power for mischief continues. It causes blood-particles to shrink, probably by ab-

* Persons who are obliged to stand much of the time are often troubled with what are called *varicose* veins. The forces that cause circulation are not sufficient to raise the blood from the feet to the heart through so many hours without rest; and in consequence the blood presses back on the veins until they yield to the pressure and gradually enlarge. The valves soon become useless, increasing the pressure and the enlargement. The only remedy is a change to some employment that will require less standing.

sorbing moisture from them, so that they can not take up the proper amount of oxygen in the lungs. As a result, incomplete combustion takes place in the capillaries; the veins receive half-burned particles which the lungs can not expel; dead matter enters the arteries, vitiating the blood; and the repair of waste is interrupted or imperfectly performed.

The continual use of alcohol also often changes the muscular tissue of the walls of the heart into a fatty substance which can not bear the strain put upon it. In consequence, when a person gets in this condition he has no strength to move about, and often he can not stand. Sometimes the weakened walls burst, causing instant death.

The constant presence of alcohol is also felt in the arteries. It causes an enlargement of the minute vessels, so that blood accumulates in them and interrupts the usual flow through the body. This is shown by the flushed face of a person who has been drinking. The effect of a single drink will soon pass away, and the arteries will regain their form; but the red faces and redder noses of those who drink to excess show that these vessels may become permanently enlarged.

Hygiene of the Circulation.

I. We should breathe pure air, and frequently take long, deep breaths, so that the blood may be properly purified.

II. We should not take into our stomachs anything that enters the blood but does not become a part of it.

III. We should avoid the use of anything that disturbs the regular action of the heart and prevents the full nutrition of the body.

IV. We should relieve the heart of much hard labor by taking regular and sufficient exercise.

V. Should the heart show signs of weakness, we may favor its recovery by taking a reclining position.

VI. We may also greatly assist circulation, and so relieve the heart, by daily rubbing the skin briskly with a brush or a coarse towel.

VII. We should avoid the use of all substances that tend to enlarge small blood-vessels and give a permanent redness to the face.

Something to Find Out.

1. When, and by whom, was the circulation of the blood first discovered?

2. How much blood does the heart move in an hour? in a day? in a year?

3. If half the blood flows to the upper extremities, an average of one foot above the heart, one pound of blood is raised how many feet in a minute? how many in an hour?

4. How can we tell the difference between a vein and an artery that is near the surface?

5. Which way does the blood flow in the arteries? in the veins?

6. When a blood-vessel is ruptured, how can we tell whether it is an artery or a vein?

7. If a vein is wounded in one of our limbs, how may the flow of blood be stopped?

8. On which side of the wound should the band be placed?

9. In case an artery is wounded, where should the band be placed? Why?

10. When an accident occurs, and blood is flowing freely, what should we use as a band?

11. How can we draw the band tight enough to stop the flow of blood?

12. If the wound is on the head, neck, or trunk, what is to be done?

13. In case of serious wounds, what next is to be done after stopping the flow of blood?

14. When blood flows from the veins, what change in it takes place from exposure to the air?

15. How does this change affect the flow of the blood from small veins?

16. What forces besides the heart-beat assist in the circulation of the blood?

17. How does a reclining position relieve the heart?

18. In its effect upon circulation, how does the work of a farmer compare with that of a clergyman?

19. How does the work of a cook compare with that of a sewing-girl in its effect upon the heart?

20. How may a person whose business confines him to a sitting posture relieve his heart of extra work, and so preserve his health?

21. Why should clerks in stores be permitted to sit a portion of the time?

22. In regard to circulation, to what particular danger are conductors on railroads exposed?

23. When attending school, what should we do to promote circulation?

24. Why is exercise out-of-doors usually better for the health than exercise in the school-room?

25. If a person is found exhausted, with his skin pale and cold, what is the trouble as regards circulation? What is the remedy?

26. When a sudden chill drives the blood away from the surface, what should be done at once?

27. What are some of the common causes of chills?

28. What are some of the ways of stopping persistent bleeding at the nose?

29. When persons faint, in what position should they be placed, and what remedies should be applied?

30. In what way can we avoid the red blotches on the skin which come from the use of "strong drink"?

CHAPTER VI.

HOW THE BODY IS ABLE TO MOVE.

Motion necessary to Life.—In finding out how the body is nourished, we have seen that motions are required. To get and prepare the food which the body needs, we must make many movements of the arms, the legs, and various other parts of the body. To chew the food, we must move the jaws. The rings of the esophagus must successively contract, in order to force the food into the stomach. The stomach must keep up a vigorous action, in order to churn its contents into chyme. The heart must keep on contracting and expanding, in order to send the blood through the arteries to the various parts of the system. The movements by which breathing is carried on must never cease. The head must move in various directions, in order to pay attention to what is going on about it. In fact, the parts of the body are always in motion. Besides the motions which we notice, there are always going on within us many movements which we do not notice, but which are necessary to our existence; and, when we can no longer discover any motion in the body, we know that it is dead.

The Muscles.

In order to produce all these motions, it is plain that the body must be provided with proper apparatus; and, on examination, we find that the greater part of what we call flesh is collected into bands, and so fastened to the various parts of the body as to pull them in the different directions required. These fleshy bands are called *muscles.* They are about five hundred in number, and have many different sizes, shapes, and lengths, according to the work they have to do. Besides their use in producing bodily motion, in which they may be compared to the ropes of a ship, they are so arranged as to give beauty and symmetry to the form.*

General Structure of Muscles.—The steak which we eat for breakfast, and all the other lean meat which we have, is muscle. When we examine such a piece of meat especially after it has been boiled, we find that it is made up of fibers, all extending in the same direction, and bound together by a thin membrane called *connective tissue.* When the fibers are placed under a microscope, they are seen to be composed of a collection of still finer strands, or threads, called *fibrils.*† Some of the muscles are round, some are flat; some are not more than a sixth of an inch long, while others are more than

* The plumpness of the body is still further increased by the layers of fat with which the muscles are surrounded.

† In the muscles which are controlled by the will, the fibers are crossed by regular lines, or stripes. There are about ten thousand of these lines to an inch, and the muscles in which they appear are said to be striped, or *striated.*

two feet in length. Most of them have a large body, or *swell*, in the middle, and gradually grow smaller toward the ends; but a few are small in the middle and large at the ends.

FIG. 11.—The muscles and tendons of the lower arm, showing also the ligament encircling the wrist.

Tendons.—Some of the muscles are joined directly to the bones upon which they act; but most of them become smaller and tougher toward the ends, and at last terminate in strong, bluish-white cords, called *tendons*. The tendons are directly attached to the bones. They have no power of contraction. Wherever the tendons or muscles have a tendency to pull away from their positions, as at the wrist and the ankle, they are bound in place by stout bands, called *ligaments*.

Hollow Muscles.—Some of the muscles are not intended to connect one part with another, but form vessels to contain fluids. Such are the heart and the middle or muscular coat of the stomach, which have already been described.*

How the Muscles Act.—All the muscles have power to contract or become shorter; and, when the exciting cause is removed, to re-

* The muscular fibers of the blood-vessels, of the lymphatic vessels, of the alimentary canal, of the ducts of the glands, and of the iris of the eye, are so arranged as to form hollow muscles.

turn to their ordinary forms. Those whose contraction is under the control of the will are called *voluntary* muscles. Such are those by which the motions of the limbs are produced. Those which contract without any conscious action of the mind, as the heart and the stomach, are called *involuntary* muscles. Some, like those which enable us to breathe, usually act of their own accord, but may to a certain extent be influenced by the will. Many of the muscles are arranged in pairs, one causing motion in a certain direction, and the other causing motion in the opposite direction.

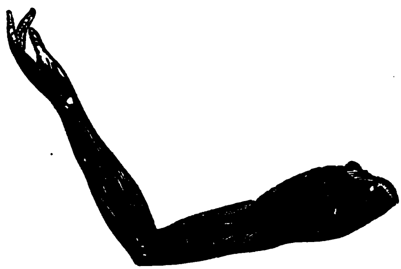

FIG. 12.—The left arm, showing the muscles in action.

The muscles that bend a joint to move any part are called *flexors;* those that extend the parts again are called *extensors.*

For example, when we bend the arm at the elbow, the large muscle in the front of the upper part of the arm contracts; and when we straighten the arm again, the muscle on the opposite side of the arm contracts. When there is a great variety of motions in a single joint, or in any organ, each distinct movement requires a separate muscle. The swing of the arm at the shoulder, the roll of the eye, the twisting of the wrist and of the ankle, are examples of this arrangement. The

contraction of muscles attached to bones gives motion to the limbs, the trunk, and the head. The action of the hollow muscles gives the motions necessary for the functions of the internal organs and for the circulation of the blood.

FIG. 13.—The muscles of the legs, as in the act of walking.

How the Muscles gain Strength.—We have already seen how the blood carries off the worn-out tissues of the body, and leaves in their place new material to repair the waste. The muscles are thus nourished by the food in the same manner as the other parts of the body. But Nature has also provided that those parts of the body which work the hardest shall have the most help and the most abundant nourishment. So, whenever a muscle is used a great deal, the blood carries to it an unusual amount of material to make and to keep it strong. It therefore happens that those muscles which are used most become largest and strongest.*

* The arm of a blacksmith is used so much and so vigorously that its muscles become, not only much larger than those of an ordinary person, but also much harder. The same is true of those who practice

The Muscles need Rest.—So long as the muscles are in motion they are wearing out. To give time and opportunity for the repairs which are needed and which Nature desires to make, the motion of the muscles must cease from time to time. After we have used any muscle a proper length of time, it becomes tired. This is Nature's signal that it has done enough, and needs to be repaired. When a muscle is thus weakened and Nature has given the signal for rest, it is just as unwise to use it as it is to use a bridge which has been pronounced unsafe, or a rope with broken strands. Its use may perhaps continue for a time without serious consequences, but it may result in permanent injury of the weakened part, and possibly the death of the offender.

"Exercise for Health, not for Strength."—As there are in the world enough useful things to do, it is best to fit ourselves to do them, instead of fitting ourselves to perform useless feats of strength. It is the duty of every person to be as healthy as possible, and to so train the body that it can carry out the directions of the mind. Therefore, any kind or amount of exercise that will keep the whole body fresh and vigorous is desirable; but any kind or amount of training that is designed to develop one part of the body at the expense of the rest, solely for the purpose of display, should be discouraged. The amount of vitality at our disposal, and our capacity for work, may probably be increased by judi-

rowing, or who engage in any business requiring unusual muscular effort.

cious exercise; but there seems to be a limit to this increase. If we perform exhaustive bodily labor, the mind can not have so large a share of our vitality as would otherwise be the case. On the other hand, long and vigorous action of the mind exhausts so much of our vital power that the body can not be so active.

This inclination of Nature to give the most help to the part that is working hardest or has the most to do, is the reason why we should not try to do any bodily or mental work immediately after a hearty meal, as the vital powers are then needed in the processes of digestion. For the same reason we should not eat more than we need; for, if we do, so much vitality will be spent in digestion that we can not do the bodily or mental work of which we would otherwise be capable.

Hygiene of the Muscles.

I. We should eat plenty of wholesome food, in order that the muscles may grow.

II. We should exercise all the muscles of the body, so that they may become strong and healthy.

III. We should exercise all the muscles frequently, to quicken the flow of blood in the veins, so as to take off some of the strain from the heart.

IV. We should not exercise to such an extent that all the vital forces of the body are used up in muscular action.

V. Any kind of exercise may become more injurious than useful, if it is allowed to overstep the bounds of moderation.

VI. After each period of activity, the muscles need rest—daily rest after daily toil, and a long period of rest after the exhaustive strain of long-continued work.

VII. We should carefully avoid all habits of

FIG. 14.—Improper and proper positions in sitting.

posture, movement, or dress that will interfere with the free development and action of all the muscles.

VIII. In sitting, we should always keep the body as nearly erect as we can without special inconvenience.*

IX. All the movements of the body should be

* We can accustom ourselves to sitting erect by always being careful to sit well back on a chair, and not upon its edge, as the latter position distorts the spine and produces round shoulders.

as graceful as possible, in order that they may be agreeable to others.

X. Calisthenics and gymnastics are well adapted to give grace to the movements of the body, and also furnish excellent exercise for young persons. They should, therefore, be generally used in schools.

XI. With all their other exercise, children need

FIG. 15.—Proper and improper positions in standing: 1, a vertical line; 2, the spinal column.

plenty of active play to keep their muscles in a healthful condition.

XII. All kinds of athletic sports and manly ex-

ercises that are not actually dangerous should form a part of every boy's education.

XIII. Lawn-tennis, croquet, horseback-riding, or similar exercises, should form a part of the life of every girl who is not otherwise provided with active physical employment.

XIV. When work distorts the body by giving excessive exercise to the muscles that throw the shoulders forward, we should remedy the evil by purposely exercising the muscles that draw the shoulders back.

XV. We should avoid the habitual use of beer, because it has a tendency to turn healthy muscle into a kind of spongy fat.

XVI. When in health, we should avoid the use of all stimulants and narcotics, as they tend directly to weaken the muscles and to diminish muscular action.

Something to Find Out.

1. Why are the muscles of the right arm usually larger than those of the left?

2. Why are so many men, who work hard, round-shouldered?

3. In what way can the tendency to become round-shouldered be prevented?

4. What good comes from the practice of the game of base-ball? What caution needs to be observed?

5. What is the effect of a tight band around a muscle?

6. When the fist is clinched, where do the muscles contract and become rigid?

7. Does the expansion as well as the contraction of a muscle upon one of the limbs produce motion?

8. Why is better exercise obtained by rowing than by walking?

9. Why is it wrong to keep children still for a long period at a time?

10. When children are restless in school, what are some of the probable causes?

11. What are some of the advantages to be gained by "going a-fishing"?

12. What is the best time for muscular rest?

13. Will it tire a horse more to travel on a level road, or on a moderately hilly one?

14. Why can not the arm hold out a weight for a long time?

15. Why should we not engage in active muscular exercise just before eating?

16. After a period of hard study, what kind of exercise should be taken?

17. In running, or other violent exercise, what peculiar symptom tells us when to stop?

18. What is the consequence, if we do not obey the command?

19. What is the best employment for the half-hour before going to bed?

20. When a boy or a girl is not really ill, what do stooped shoulders and a shuffling gait indicate?

21. Why does going half a mile on an errand sometimes tire a boy more than walking five miles to see a circus?

22. If a person is free to choose his work, what principle should guide his choice?

CHAPTER VII.

HOW THE BODY IS ABLE TO STAND.

The Need of a Bodily Frame.—If the body were made up entirely of soft materials like the muscles, it might be capable of motion in its different parts and some movement as a whole. But it would not be able to stand erect, or to retain any permanent shape. Its beautiful proportions, its graceful motions, and its dignified bearing would all be impossible; and a human being would be nothing more than a mass of flesh physically inferior to almost every other animal in existence. That it may be able to stand erect and keep its proper form, the body needs a strong and solid frame-work. This is furnished by the bones.

The Bones.

Uses of the Bones.—The bones have three distinct uses. They give shape to the body, and keep the various parts and organs in position. They protect organs which would otherwise be exposed to injury. They afford a solid place for the attachment of muscles by means of which motion may be given to the various parts of the body.

Forms of Bones.—In order to meet these requirements, the bones have many different sizes and shapes, and are arranged in the various ways best suited to the purposes for which they are designed. Those whose chief use is to protect are made strong and thick, and of such shape as to offer most resistance with the least material. Where several bones unite to protect any organ, they are placed around it in such a manner as will defend it most effectually. Those whose chief use is to furnish support to the body, or a base of attachment for other portions, are very thick and solid, and of such shape as will best adapt them for staying in place. Those designed to strengthen columns, or to produce motion, are long and straight. Others, which have more than one of these functions to perform, are so ingeniously constructed that they combine two or more of these features.

Structure of the Bones.—The long bones, which form the frame-work of the limbs, consist of a slender shaft of hard, compact material, and have enlarged extremities composed of a soft, spongy material.* The shaft is hollow in the middle, and contains *marrow*. This is composed chiefly of blood-vessels and fat, and supplies the bone with nourishment. The other bones are spongy inside, and hard and fine in texture on the outside.† The bones are

* The increased size and the spongy character of the extremities furnish better attachments for the tendons, and the increase in size makes up for the decrease in hardness.

† The bones are full of fine tubes from $\frac{1}{200}$ to $\frac{1}{20000}$ of an inch in diameter. Through these the blood passes to carry on the work of repair, as in the other portions of the body.

covered with a tough, fibrous membrane, except at the joints, where they are covered with cartilage. This fibrous membrane is called the *periosteum*, and when it is removed the bone dies.

FIG. 16. — Upper portion of the right femur, sawn in two lengthwise, showing the difference of texture between the shaft and the extremity.

Materials of which the Bones are Made.—When a bone has been burned for a sufficient length of time it will be so brittle that it can be easily broken. If it be soaked in diluted muriatic acid it will entirely lose its stiffness, and, if of sufficient length, can be tied in a knot. By these experiments it will be seen that the bones contain a mineral or earthy substance, which makes them stiff and hard, and a certain amount of animal matter, or gelatine, which binds them together and gives them a slight degree of elasticity. The earthy substance is mostly lime, and composes about two thirds of the weight of the bone.* In childhood the bones are more largely composed of animal matter than in old age. On this account, children are less likely to have their bones broken by

* The color of bone in the living person is a pale-rose tint, inclining in early life to red, in old age to a yellowish white. Bones assume a beautiful white when deprived of the oily fluids which pervade them. The specific gravity of fresh bone is greater than that of any other animal substance.

blows and falls; but, for the same reason, they are more likely to become deformed by remaining in an improper position. The legs of young children are often bent out of shape by too much use of them before their bones are firm enough to support the weight of the body. In old persons the bones are so brittle as to break very easily, and when broken they do not readily unite again.

Growth and Repair of the Bones.—The bones do not reach their full development before the age of twenty-five, and in persons who use the brain a great deal the skull is said to continue its growth much longer. The continual repair of worn-out parts is carried on in the bones as in the rest of the body.* When a bone is broken and the parts are brought together again, a watery substance is poured out of the fractured ends until the break is closed by a gristly formation. In due time, mineral matter is supplied to stiffen the gelatine thus provided, and the bone is finally restored to its original form and strength.

Bones of the Head.—The bone which gives shape to the head and protects the brain which lies within is the *skull.* It is rounded on top somewhat like the large end of an egg, and in front and on the sides it has openings for the eyes, the nose, and the ears. The skull is composed of two compact, armor-like plates, with a layer of spongy bone between them. The dome-like top is the best possible form

* If any red coloring-matter, such as madder, be mixed with the food of a young animal, its effect will appear within a day or two in the changed color of the bones.

for resisting pressure. The spongy layer prevents the jar of a blow being felt by the brain. The upper jaw and the bones of the nose and the cheeks belong to the skull, and are immovable. The movements of the mouth are effected by means of the lower jaw.

Sutures of the Skull.—The skull is made up of several parts joined by irregular, saw-like projections and depressions on each side, very much as we can lock the fingers of our two hands together. These lines of connection are called *sutures.* In childhood the parts of the skull are not very firmly united, but as the person grows older the union becomes more and more complete. The use of having the skull in several parts is to allow the brain to grow and to prevent a jar from affecting the whole skull.

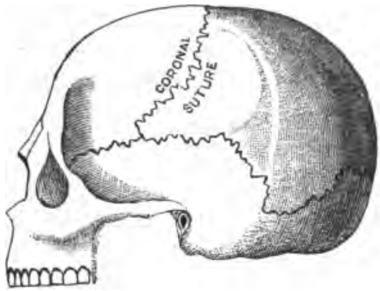

FIG. 17.—The skull, showing the sutures.

Bones of the Trunk.—The bones of the trunk are the pelvis, the spinal column, the ribs, the breastbone, the shoulder-blade, and the collar-bone.* The

* Strictly, the shoulder-blade and the collar-bone form a class by themselves. "The Upper Extremity consists of the Arm, the Forearm, and the Hand. Its continuity with the trunk is established by means of the shoulder, which is homologous with the innominate or haunch-bone of the lower limb. The Shoulder is placed upon the upper part and side of the chest, connecting the upper extremity with the trunk: it consists of two bones, the Clavicle and the Scapula." (Gray's "Anatomy.")

pelvis, situated at the bottom of the trunk below the abdomen, affords a foundation for the trunk and a solid means of attachment for the legs. It consists of the sacrum, the coccyx, and the two hip-bones, arranged in the form of a basin.

Fig. 19. The spinal column.

Attached to the pelvis, and extending up the middle of the back to the head, is the *spinal column*, or backbone. It is made up of twenty-four small, flat bones called *vertebræ*,* placed one upon another with a pad of rubber-like cartilage between each two. The spine is the main connecting structure of bone in the body, gives shape to the trunk, and contains a channel through which passes the spinal cord, an important center of nerve-distribution.†

Fig. 18.—The pelvis, showing the hip-joint and the relative positions of the spine and the femur.

The *ribs*, twenty-four in number, are in pairs inclosing the

* Of the vertebræ, seven belong to the neck, twelve to the back, and five to the loin. The sacrum and the coccyx are consolidated vertebræ, and may be included in the spinal column.

† When we look at the spine from the side, we see that it has a

chest. They are attached to the spinal column by a kind of joint which allows them to move up and down enough for the purpose of breathing. In front the upper seven pairs are attached to a strong, flat bone extending up and down and called the *sternum*, or breast-bone.*

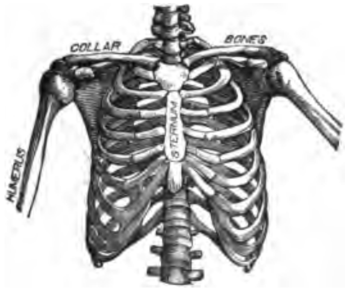

FIG. 20.—Bones of the thorax, showing the shoulder-joint, the relative positions of the spine and bones of the upper cavity of the trunk, and the shape of the ribs in a healthy chest.

Extending downward from the top of the trunk behind the arms, on each side of the spine, is a strong plate of bone, shaped like a triangle and called the shoulder-blade, or *scapula*. From the part of the shoulder-blade nearest the arm to the upper part of the breast-bone, extends a slender bone shaped much like the italic *f*, and called the collar-bone, or *clavicle*. This braces the shoulder-blade and helps to keep it in place.

Bones of the Arms.—The single long bone between the shoulder and the elbow is called the *humerus*. Of the two between the elbow and the

double curve bending back from the neck to the shoulders, then forward to the waist, and then back as it nears its lower extremity. A pivot-joint connects the two upper vertebræ, and a hinge-joint connects the vertebræ with the skull, enabling us to turn the head and move it backward and forward.

* The lowest two on each side are not attached in front, and are called *floating ribs*. The remaining three pairs are connected by bands of cartilage, and are called *false ribs*.

6

wrist, the one more closely joined to the humerus is the *ulna;* the one which moves around the ulna is the *radius.* The bones of the wrist are eight in number. The palm of the hand contains five, and the bones of the fingers and thumbs can be readily counted.

Fig. 21.—Bones of the right arm, showing their ordinary positions.

Fig. 22.—Bones of the left arm, showing the ulna and the radius in a twisted position.

Bones of the Legs.—The bones of the legs correspond almost entirely to those of the arms. That between the trunk and the knee is the *femur.* The *patella* covers the knee-joint. The main bone between the knee and the ankle is the *tibia,* and the one which braces it is the *fibula.* The ankle contains seven; and there are five in the body of the foot. The bones of the toes, like those of the fingers, can be easily counted.

Arch of the Foot.—The bones of the foot are arranged in such a way as to form an arch. When the weight of the body is thrown upon the foot, as in walking and leaping, the top of the arch is pressed downward, and the bones spread outward, making the foot wider than before. In this way the body is preserved from shocks which would otherwise greatly injure it.*

* Tight shoes, and shoes made of coarse, heavy leather, are injurious in many respects. They prevent the spreading of the foot, and

Bony Cavities of the Body.—The cavities of the body which are formed and protected by the bones are thus seen to be the skull, the chest, and the abdomen. The skull contains the brain, which is the most sensitive organ, and has no motion. Hence the skull is absolutely unyielding. The chest not only protects the organs within, but varies in size to accommodate the lungs in respiration. Accordingly, it is not only strong, but expansive. The pelvis supports the organs of digestion, and for this purpose is shaped like a basin. It also sustains the whole body on the pillars formed by the legs. It is, therefore, thick and unyielding.

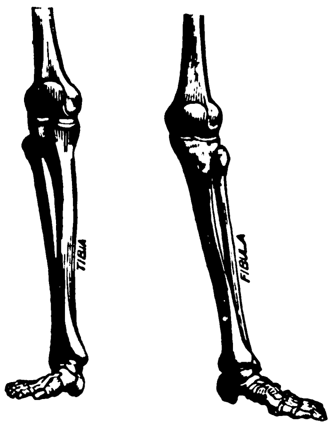

FIG. 23.—Bones of the legs, in their relative positions.

Bodily Movements.

How the Muscles move the Bones.—The cause of motion in the body is the contraction of the muscles. In the hollow muscles the result of contrac-

change the act of walking from a free, springing motion, to a stiff, unnatural gait. The bones become distorted and overlap one another, producing permanent deformity. The continued pressure upon the flesh produces corns, bunions, and ingrowing toe-nails. High heels throw the weight too far forward, and heels placed under the hollow of the foot not only prevent the spring of the arch, but quickly produce deformity.

tion is to diminish the capacity of the vessels which the muscles form. Where the muscles connect two bones, the contraction draws the connected bones toward each other. The lower jaw is drawn upward by a strong muscle called the *masseter*. This is attached to the cheek-bone, and acts directly to

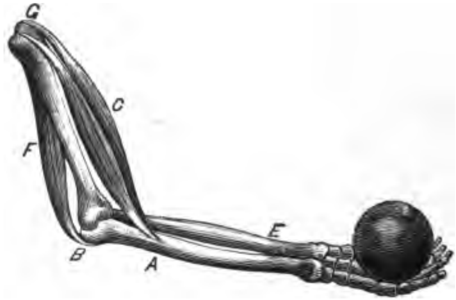

FIG. 24.—The arrangement of bones and muscles by which the arm is bent: *A*, the radius; *B*, the elbow; *C*, biceps; *E*, ulna; *F*, triceps; *G*, shoulder-joint.

bring the jaws together. The arm is bent by a strong muscle called the *biceps*. This is attached at one extremity to the shoulder-blade, and at the other to the radius just below the elbow.* The opposite movement, by which the arm is straightened, is caused by a similar muscle, called the *triceps*, on the opposite side of the arm. This, however, is at-

* When the biceps contracts, the radius is drawn upward toward the shoulder; but, as the tendon of the biceps is attached to the radius so near the elbow, it plainly requires more muscular effort to bend the arm than would be required were the tendon of the biceps attached nearer the wrist. The enlargement of the elbow-joint, by raising the tendon away from the arm, brings it more nearly at right angles to the radius, and thus gives it more effect in bending the arm than it would have were it parallel to the radius.

tached to the ulna.* The muscle which throws one leg across the other reaches from above the hip on the outside to below the knee on the inside, and is called the tailor's muscle, or *sartorius*, because it is the one which a tailor uses in taking his peculiar position on the bench. Wherever a twisting motion is to be produced, there is a similar arrangement. A rotary movement of the eyeball is produced by a muscle passing through a pulley-like loop.

How Shocks are Distributed.—Every one knows that when a person needs to jump from a high place the shock felt will be much less if the body is allowed to bend freely than if it is kept rigid. The hand of a catcher who wishes to feel the sting of the ball as little as possible is allowed to move backward when the ball is caught. It will be readily seen that, if in these cases the limbs were held rigidly in a straight line, the firm ends of the bones could not fail to strike heavily against each other, much as the buffers of two railway-cars do when the cars collide. But when the joints are bent and the muscles are relaxed, the main force of a shock is expended in further bending the joints, and the shock felt by the limbs in the direction of their length is very slight.

In jumping, if we strike upon the toes, the shock is first moderated by the arch of the foot, which acts like a spring. The force of the shock is further distributed at the ankles, the knees, and the hips, by

* This antagonistic arrangement, and this alternate action of the muscles, are essentially the same in all the hinge-joints.

the three curves in the spine, and lastly at the joint which connects the spine with the skull.

Hygiene of the Bones.

I. The food and drink that we take must contain enough lime to nourish the bones.*

II. In childhood, before the bones harden, they should not be made to sustain heavy weights, nor should they be subjected to a continuous pressure.†

III. Exercise, giving the proper amount of pressure and strain, is necessary to promote the growth and nurture of the bones.

IV. The bones of the foot should not be compressed so as to prevent the free spring of the arch and the spreading of the bones, when the foot is called upon to sustain the weight of the body.

V. No tight bands should be worn about the ribs to interfere with the movement of the bones in breathing.

VI. We should sit and stand erect, so as to prevent the distortion of the bones which comes from the habit of bringing the shoulders forward and bending the head down.

VII. We should avoid resting one arm higher

* Farmers have long noticed that cattle often do not thrive in an old pasture. Their bones become tender and are easily broken, and the whole body suffers in health. The reason is that those elements of the soil that make bones have been used up, and the remedy is to supply fertilizers that contain lime.

† A baby's legs are often made crooked by trying tco early to make it walk. In school, many a child has been deformed by sitting on so high a bench that its feet can not touch the floor.

than the other, as this practice tends to produce a permanent curvature of the spine.

VIII. When a bone is injured or a joint sprained, we should keep perfectly quiet until the part is fully recovered.

Something to Find Out.

1. What are the appearance and composition of a bone after it has been thoroughly burned?

2. What are the appearance and condition of a bone after it has been soaked in diluted muriatic acid?

3. In making soups, what ingredient is derived from the bones, and how is this ingredient obtained?

4. What is the comparative effect of a sudden blow upon the bones of young and of old persons? What is the effect of pressure?

5. When bones are broken, what are some of the conditions necessary for their repair?

6. In what plays is there particular danger of getting bones broken?

7. Why is the skull at the top rounded in the shape of a dome?

8. What animal is so constructed that its upper jaw can be thrown back?

9. Why is the pelvis a large and very strongly constructed bone?

10. What is the use of the rubber-like cartilages between the vertebræ of the spinal column?

11. After a day of active exercise in work or play, why are we shorter than when we first arose in the morning?

12. What effect does wearing a tight band around the waist have upon the shape of the ribs? upon

the movement of the ribs? upon the movement of the diaphragm? upon breathing? upon the position of the organs of the chest and abdomen? upon the circulation of the blood?

13. Why should the soles of shoes be broad? Why should the heels be broad and low? Why should the upper leather be soft and pliable?

14. Why do people wear tight clothing and tight shoes?

15. What reason is there for making shoes with high heels, or with the heel in the hollow of the foot?

16. In what way are corns produced?

17. What name is applied to the lower limbs when the bones have become permanently bent?

18. In the bones of the lower arm, which bone is attached at the elbow, and which at the wrist?

19. When you saw in two, lengthwise, a beef or mutton bone taken out of the leg, how does the interior appear?

20. Why are the bones and joints of the toes so frequently deformed?

21. Why does a person in catching a ball draw his hands back the moment the ball touches them?

22. Why do we strike on the ball of the foot when we jump?

23. Why, in walking or jumping, is it best to keep the joints bent?

24. When we unexpectedly step down a few inches, what effect is produced? Why?

25. Why do so many people have a stiff, awkward gait?

CHAPTER VIII.

HOW THE BODY IS COVERED.

The Usefulness of the Bodily Covering.—Every one who has met with an accident, by which a piece of the skin has been torn off, can understand how important it is that there should be some sufficient protection to the muscles and other sensitive organs which lie near the surface of the body. Besides the pain caused, the removal of the skin allows poisonous or irritating substances to enter and injure the body. In addition to these well-known protective uses, there are many other offices which the skin performs. It assists in removing waste matter from the system, absorbs matters brought in contact with it, is the termination of the nerves of touch, aids the lungs in taking in oxygen and giving out carbonic acid, regulates the temperature of the body, and, in general, not only defends the organs within, but helps them when they are unable to do their full amount of work. It also, with the hair and its other appendages, does much to beautify the person and give expression to the emotions and the thoughts.

The Skin.

General Structure of the Skin.—The thickness of the skin varies in different parts of the body. Where it is much exposed to wear, as on the soles of the feet or the palms of the hands, it becomes very thick and is called a *callus*.* In other parts it is very thin and delicate. At the ends of the fingers and the toes, where unusual protection is required, it grows into shield-like plates called *nails*. On the scalp, where special protection of the brain is needed, it puts forth a thick covering of hair.

Layers of the Skin.—The skin is divided into two principal layers. The outer one is called the *scarf-skin*, *cuticle*, or *epidermis*. It is made up of little cells flattened into scales. It has no blood-vessels or nerves, and may be cut or pinched without giving pain. As the cells near the surface become dry and hard from lack of nourishment, they fall off and new ones from beneath take their place.† The lower part of the scarf-skin contains the pigment, or coloring-matter, which determines the color of different races and different individuals.‡ The inner layer

* When this thickened skin is at the same time continually subjected to hard pressure, as by tight shoes, it forms an excessively hard, horny lump called a *corn*. Any means of softening the lump, as soaking it in warm water, together with the removal of the cause, will often remedy the evil.

† It is these worn-out cells, or scales, that separate from the skin in bathing. They also constitute the *dandruff* which forms on the head and comes off in small, white particles, especially when the hair is combed or brushed.

‡ When the amount of coloring-matter in the pigment-cells is very slight, it produces a blonde complexion; when greater, a brunette

of the skin is called the ***true skin, cutis vera,*** or ***derma.*** The part of this nearer the surface is composed of

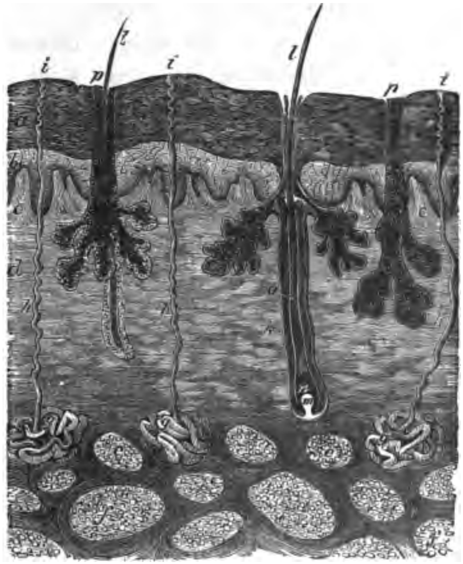

FIG. 25.—Vertical section of the skin, magnified: *a*, scarf-skin; *b*, pigment-cells; *c*, papillæ; *d*, true skin; *e, f*, fat cells; *g*, sweat-glands; *h*, outlets of sweat-glands; *i*, their openings on the surface of the skin; *k*, hair-follicle; *l*, hairs projecting from the skin; *m*, hair-papilla; *n*, hair-bulb; *o*, root of hair; *p*, openings of oil-glands.

The colors of the different races depend upon the kind and amount of pigment in these cells. The amount of coloring-matter is increased by exposure to heat and light. Every one knows that those who spend much time in the open air, especially in summer, become tanned and freckled, and that when winter comes again, or they remain in-doors for a time, the tan and freckles mostly pass away. This is because the light and the heat increase the pigment. When this takes place in spots, it causes freckles only; when it affects the whole exposed surface, it causes tan.

When persons of a light complexion go from countries distant from

little elevations called *papillæ*. These contain blood-vessels and nerves, and from some of them arise the *hair-follicles*, or the openings through which the hairs reach the surface of the skin. Below the papillæ lies the main part of the true skin; and between the true skin and the flesh is a layer of fat, which varies in thickness in different persons.

How the Skin is kept Soft.—All over the surface of the body are little tubes which descend into the true skin, like the finger of a glove with the end downward. Some of these tubes end in little bags somewhat resembling clusters of grapes. These groups of bags are called *sebaceous glands.** They collect oil from the blood and pour it out through the hair-follicles upon the scarf-skin to keep its cells from falling off too rapidly, and in this way the skin and the hair are kept soft and pliable.

How the Skin casts out Waste Matter.—In the layer of fat beneath the true skin lie the coiled ends of tubes, which reach to the surface of the skin. These filter off from the blood the perspiration, and are called the *sweat-glands.*† The perspiration con-

the equator into the very warm regions between the tropics, they become almost as dark as the native inhabitants. When the natives of very hot countries live for a long time in cooler latitudes, their complexion gradually becomes lighter. In some persons the pigment is entirely wanting. Such persons have a pallid complexion and pink eyes, and are called albinos.

* The oily contents of these glands sometimes harden and form the black specks which appear in the skin.

† A magnifying-glass will disclose on the ridges on the palm of the hand over three thousand openings of the sweat-tubes in every square inch. There are also great numbers on the soles of the feet; and even where least numerous, as on the back, there are about four hundred

sists chiefly of water, but contains also a certain amount of waste material. In this way the skin aids in keeping the body free from impurities.

Other Means of casting out Waste.—A considerable part of the waste matter of the body passes off through the kidneys. These organs lie in the abdominal cavity, one on each side, just below the "small of the back." They absorb from the blood impurities which can not be expelled at the lungs. The waste which passes off through the kidneys and through the skin is much alike, and in their action they assist each other. When the kidneys are diseased, the skin does more work; and when the skin is out of order, as from the effects of a cold, the kidneys become more active.

How the Skin regulates Heat.—It is a familiar fact that, in very warm weather, the heat of a room can be lessened by sprinkling the floor. This is because heat is used up in changing the water into vapor, and so is not able to increase the temperature. The same is true of the perspiration which is thrown out from the sweat-glands. Usually the perspiration is poured out so gently that it is not noticed, and is said to be *insensible*.* But, in very warm weather, or when the body is heated by exer-

present to every square inch of surface. Indeed, it has been calculated that there are twenty-eight hundred sweat-glands, on the average, in every square inch of the body, making a total in an average-sized man of about seven million, which is equivalent to twenty-eight miles of the tubing, since each tube is a quarter of an inch long.—("The Skin and its Troubles.")

* The insensible perspiration of an adult person amounts to about twenty ounces in twenty-four hours.

cise, it forms visible drops. The more rapidly the perspiration flows out, and is changed to vapor, the less we feel the heat.* But we need to drink much more, in order to keep a proper amount of moisture in the body.

How the Skin Absorbs.—The true skin contains a great number of blood-vessels,† which distribute nourishment to the papillæ, the roots of the hair, the oil-glands, and the other parts of the skin; and which carry back the exhausted blood to the heart. It also contains lymph-vessels, which commence as little spaces between the cells and fibers of the skin, and gradually form tiny tubes to carry away the lymph into the blood. Whenever any substance soaks through the scarf-skin, it is caught up by the lymph-vessels and the veins, and is hurried away to various parts of the system.‡

Why the Skin should be kept Clean.—It is plain that the natural waste of the scarf-skin, and the

* It is on this account that "fire-kings" can remain in ovens heated as high as 600°.

† The presence of red blood in these blood-vessels gives to the skin its ruddy color. When from any cause the blood rushes to the skin, this ruddiness is increased. When this rush of blood is supposed to be caused by some emotion, the effect is known as blushing. When from any cause the blood is withheld from these vessels, its absence is known as pallor, or paleness.

‡ The power of the skin to absorb is illustrated by the fact that persons have been kept alive by baths of soup and other nourishment. It may have been for a similar purpose that baths of wine have been sometimes used by luxurious persons. On the other hand, it is well known that persons whose work compell them to handle poisonous substances frequently lose their health by continual contact with the materials used. Similar effects are sometimes produced by so slight a cause as a kiss from one who is affected by disease.

pouring out of oil and perspiration from the glands, must result in the accumulation of much impurity upon the surface of the skin. It is plain, also, that if this mass of impurity is allowed to remain, it must not only be in itself offensive, but must derange the action of the organs of the skin. The amount of impurity thus thrown out of the body is much increased by any unusual excitement of the nerves caused by excessive emotion. Besides these collections, the dust and dirt which come upon the skin in the course of our ordinary work require frequent removal. If these impurities are not speedily removed, they derange the action of the skin, and, through the skin, the comfort and capacity of the whole body.*

How to keep the Skin Clean.—The only means of keeping the skin clean is frequent and thorough bathing of the entire body. This should be attended to every day, if possible. If from any cause this frequency is not possible, the nearest approach to it should be made. Under any ordinary circumstances, such a bath may be taken by every person at

* Other animals show us the good of being clean: a badly groomed horse is never sound or spirited, and a dirty pig puts up one fourth less flesh than a clean one. Yet it may be feared that some human beings are only thoroughly washed at birth and at burial.—(Mapother.)

Many an evil action is the remote result of a neglect of cleanliness. When it is habitual, it brings about a degraded state of mind; and, even when it is temporary, its irritating effect upon the disposition is often noticeable. It is a fair question whether, in many cases, a bad boy might not be converted into a good one by means of a bath and a change of clothes. The public baths in many cities are really very important agencies in suppressing wrong-doing.

least once a week. Besides this bathing of the whole body, those parts which especially need it should be washed as often as any impurity is discovered upon them. For merely cleansing the body, tepid or warm water is the most effective. But such a bath is relaxing in its effect, and should not be used very often. The cold morning-bath is very beneficial to perfectly healthy persons, not only for its cleansing power, but also for its stimulating effect. If a bath-tub is used, a simple plunge will in most cases be sufficient. The most convenient and profitable morning-bath within the reach of a majority of persons is the sponge-bath. This requires only a basin of water, a sponge or wash-cloth, and a towel. Only so much soap as is necessary should be used.

If the skin does not recover its warmth in a short time by vigorous rubbing of the body with a coarse towel, the person is not in proper condition to profit by cold baths. The other forms of bathing are either medicinal in their nature, or partake of the nature of luxuries.*

* Sea-bathing is a very popular form of the natural bath, and it is preferable to bathing in river-water or spring-water, because the sea is seldom so cold as are the latter. A sea-bath has also another great advantage over all other forms of bath, and that is that it is taken in the purest air possible; and in considering the effects of sea-bathing, it is impossible to separate the effects of sea-air from that of the sea-water. The sea-bather is also constantly inhaling the spray of the sea-water, and thus obtains whatever benefit is to be got in this way. If he can swim, he enjoys all the benefit of exercise. The motion of the water and the buffeting he gets from the waves act as a powerful excitant to the skin; and, lastly, the salt in the water adds considerably to the stimulating action. Reaction more readily occurs after a sea-bath than after a river-bath.—("Baths and Bathing.")

No kind of full bath should be taken within less than two hours after a hearty meal, because the process of digestion will not allow so much distraction of bodily energy. The soap used in bathing should not be very strong, because such soap will remove too much of the scarf-skin, and, in cold weather especially, will cause the skin to chap.

The Hair.

What it Is.—The follicles from which the hairs grow, and the oil-glands which cling to their roots, have already been mentioned. The hairs themselves are modified forms of the scarf-skin. Human hairs are solid, but the central parts are made up of cells loosely packed together to form a *pith*. The *shaft* of a hair is the part outside the skin. The *root* is the part which lies below the surface. At the side of the hair are little muscles, by which it may be made to "stand on end." The color of the hair is due to a pigment in the cells. The flatter the hairs are, the more readily they curl.*

How to keep the Hair Healthy.—The health of the hair depends mainly on the general health of the body. A slight, continuous shedding of the hair, especially in the spring and autumn, does not indicate ill health. The hair should always be kept

* The hair upon the head and the face protects from cold, and shields the head from the rays of the sun in hot climates. It also breaks the force of a blow upon the head. The eyebrows prevent the perspiration from running from the forehead upon the lids. The eyelids protect the eyes from dust and other injurious matters. The short, stiff hairs of the ears and the nose are also for protection to these openings.

clean by frequent washing, and by thorough but not rude brushing. Cutting the hair tends to promote its growth. Great care should be taken to keep the scalp from undue pressure from any cause, and any covering of the head which prevents the free access of air is to be avoided.

Thinning and Grayness of the Hair.—Whatever leads to weakness of the body will injure the hair. Sometimes early grayness, or the loss of the hair, is common in a family. Sometimes they result from a local disease of the scalp; but usually they indicate a general weakness of the body, or some overtasking of the mind or the emotions. Severe illness, fear, worry, anxiety, or hard mental work, may cause either of these results.* Various hair-dyes and similar preparations are sometimes used to restore the growth or the color of the hair; but most of them contain poisonous substances, which are liable to enter the skin by absorption, and often produce serious results.

Clothing.

Why the Body should be Clothed.—The body needs to be protected by clothing as much as the flesh and other organs need the protection of the skin. Savages, and people who live in warm coun-

* The hair may become white or gray in the course of a few hours. In most cases this has occurred in connection with intense mental emotion. The cases of Marie Antoinette and Sir Thomas More are widely known, and more carefully authenticated cases leave no doubt that such a change may occur. It is supposed to be caused by the entrance of air into the pith of the shaft; but how its entrance there is effected is difficult to imagine

tries, wear much less clothing than those who are refined, and who live in colder climates. Those who go without shoes come to have the skin on their feet so tough and thick that they can walk and run without pain, even over stony surfaces; and in savages somewhat the same effect is produced by the general exposure of the body. But in civilized countries the general use of clothing has made it necessary, not only as a protection from hurt and from extremes of heat and cold, but also as a means of adornment.

How the Body should be Clothed.—The clothes we wear should be carefully adapted to the needs of the body and the demands of good taste. Parts specially exposed to injury, as the feet, need the strong protection of shoes; and these need to be heavy or light according to the service which they are intended to perform. The head needs such a covering as will keep it warm in cold weather, and cool in warm weather. It should also be such as will shield the eyes from excessive light. Flannels, other woolen goods, and furs, are best adapted to retain the heat of the body. Hence they should be used in cold weather. Cotton, linen, and silk readily conduct the heat from the body, and should therefore be worn when the weather is warm. Light colors reflect much heat and radiate little; hence are warmer in winter and cooler in summer.*

* Very many colds are caused by insufficient clothing. Whenever a sense of chilliness is felt in any part of the body, it is a signal from the nerves that more protection is needed; and this warning should be heeded, no matter in what season of the year, or at what time of day, it is given.

Special care should be taken to keep all parts of the body absolutely dry at all times. Whenever it

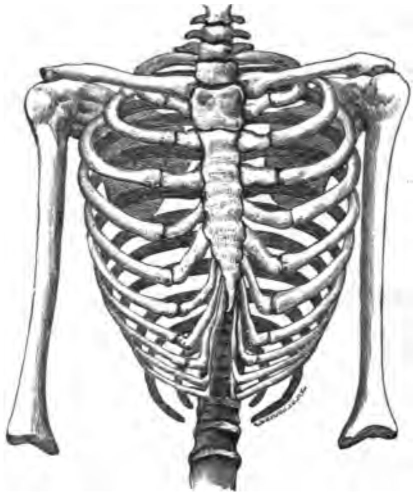

FIG. 26.—Deformity of the ribs, caused by wearing clothing tight at the waist.

is necessary to walk in the wet, the feet should be protected by overshoes, and water-proof garments and an umbrella should always be used when they are needed. But, as overshoes and water-proofs not only keep the moisture out, but also prevent the perspiration from escaping, they should never be worn in dry weather, or kept on in-doors. If, from unavoidable causes—as from excessive perspiration, being caught in a shower, or stepping into the water—any portion of the clothing becomes wet, it should be immediately removed, and dry clothing should be put on.*

* The neglect of these simple precautions has caused almost num-

The clothing should never be worn so tight as to interfere with the entire freedom of the body. Very tight shoes, and tight clothing at the waist, are the two most serious evils in modern dress.*

Hygiene of the Skin.

Since the skin is full of pores, some of which give off waste, and some of which absorb matter from the outside, it is very important that these pores be kept open. As the skin covers the entire body, it is also important that every part of it should be kept soft and elastic, so as not to press uncomfortably upon the delicate organs beneath.

From these facts, and from the foregoing discussion, the following hygienic laws in regard to the skin become obvious:

I. The skin should be kept clean, so as to allow waste matter to be readily carried off.

II. We should exercise freely, so that the blood may circulate properly in the skin.

III. The skin should be frequently rubbed, to help the circulation of the blood, to excite the secre-

berless colds, catarrhs, and more serious diseases. Pneumonia and consumption often originate from so apparently slight a cause as wearing insufficient wraps or wetting the feet.

* The apparent tendency of the times to more freedom in these articles of dress is an evidence of the benefits of physiological study; but a great amount of instruction is still needed. Shoes with high heels, by throwing the feet out of their natural position, frequently cause serious injury to various parts of the body, especially the eyes. Care should be taken to avoid any article of clothing which contains poisonous coloring-matter. No clothing should be worn which leaves any indication of color upon the skin.

tion of oil which softens the skin, and to keep the scarf-skin from clogging the pores.

IV. Draughts of air and sudden chills should be avoided, as they drive the blood away from the surface, cause the skin to shrink, and close up the pores.

V. In handling poisonous matter of any kind, we should be careful not to let it come in contact with the skin, lest it be absorbed.

VI. When, from any cause, we have but little vitality, we should not take a cold bath, because there is danger that reaction may not follow.

VII. That the hair may be vigorous, it should be kept clean, and brushed often, and the dry, harsh ends should be clipped off.

VIII. The scalp should be kept clean and be sometimes gently rubbed; then it will supply the hair with all needed nourishment, and will render the use of oil and "hair-invigorators" unnecessary.

IX. Clothing should be changed with the temperature, to protect the skin from extremes of heat and cold.

X. Clothing worn next to the skin is soon filled with waste matter, and should be frequently changed. The same clothing should not be worn day and night.

XI. The clothing should not be worn so tight as to drive the blood away from the surface of the skin, to interfere with breathing, or to prevent the free use of the muscles.

Something to Find Out.

1. Why are the nails upon the fingers and toes harder than other parts of the skin?

2. Why is the skin of the head furnished with a thick covering of hair?

3. What becomes of the waste matter contained in the "insensible perspiration"?

4. How much waste matter is thrown off from the skin in one year?

5. What harm comes from breathing air filled with this waste matter?

6. Why should the plaster walls and ceiling of a school-room be frequently whitewashed with lime?

7. Why is out-door air better to breathe than the air of inhabited rooms?

8. How may the air of inhabited rooms be kept pure?

9. What causes the peculiar effect upon the skin which is called "goose-flesh"?

10. When "goose-flesh" appears, or the skin becomes suddenly pallid, what should be done?

11. How does the skin appear when the blood circulates freely through it?

12. What internal organs are relieved by the free circulation of the blood in the skin?

13. To what danger are nurses exposed by being with persons who are ill?

14. What particular danger should be guarded against in surgical operations?

15. Why, in taking a bath, is tepid water usually safer than cold water?

16. In what way is an excessive use of soap in a bath injurious?

17. Why is a boy, when dirty, more liable to do a mean thing, than when he is clean?

18. Are all children to blame for an untidy appearance? Should they be reproached for it?

19. Why is the practice of wearing fur caps and close-fitting hoods injurious?

20. What kind of head-coverings are the best for summer?

21. What peculiar head-coverings are worn by people in very hot climates?

22. Why do we need more clothing when asleep at night, than when we are about in the day-time?

23. Why should we take off rubber overcoats and overshoes immediately on coming into the house?

24. When we are exposed to great cold or heat, why is woolen clothing better than cotton?

25. When our feet become wet and cold, how may we avoid chilblains?

26. Why do people in the Arctic regions dress in the skins of fur-bearing animals?

27. In case of a slight burn or a scald, what part of the skin rises into a blister?

28. When the skin is burned, why should the air be at once excluded?

29. Of what use are linseed-oil, plasters of flour mixed with water, and plasters of clay, in case of a burn?

30. What indicates that the true skin has been cut or burned?

CHAPTER IX.

HOW BODILY MOTION IS DIRECTED.

Bodily Organs must act in Harmony.—If each of the internal organs of the body should move without regard to the movements of the other organs, life could not exist; for life can be sustained only by all the organs acting together in harmony. If each of the external organs, as the arm or leg, were independent in its motions, the body as a whole would be unable to do any useful work, and the mind could not carry out its purposes in any direction. In order that nurture may go on in the body, and that the mind may execute its plans, all bodily movements, therefore, must be under orderly control. This control is effected by means of the nerves.

The Nervous System.

How the Nerves are Distributed.—Throughout the body there is a nervous system, which in plan and distribution is very much like the system of blood-vessels. The nerves, starting from a nervous center, divide and subdivide, until they become exceedingly minute, hair-like threads extending to every organ in the body. In the skin they form a

net-work so close that the finest needle can not pierce the skin without coming in contact with some of them.

Like the blood-vessels, the nerves are double, one set going out from the nervous center, and the other returning to it. Unlike the veins and the arteries, the two kinds of nerves are not distinct, but their fibers unite so closely that they everywhere appear as a single thread.

Nerve-Matter.—The nerves are made up of two kinds of matter, white and gray. Under the microscope the white matter appears as minute threads and the gray as tiny cells. The white matter is much greater in quantity than the gray, but the two are found together in all the nerves of the body.

The Brain.—The principal nerve-center, corre-

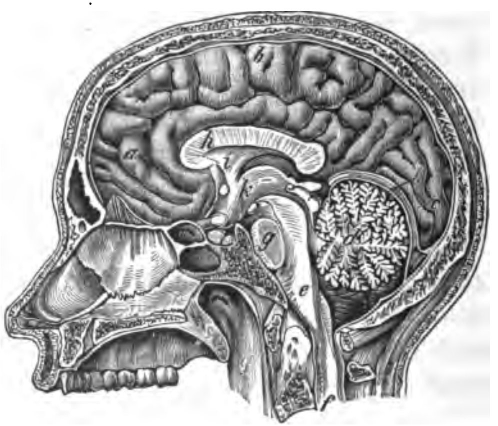

FIG. 27.—The brain inclosed in its membranes, and the skull: *a*, *b*, *c*, convolutions of the cerebrum; *d*, the cerebellum; *e*, medulla oblongata; *f*, upper end of the spinal cord; *g*, *h*, *i*, *k*, central parts.

sponding to the heart in the circulation, is the brain.

is care-
he front
ghths of

tions of the

ıd lower

ɔosed of
:hin cov-
is made
ions, giv-
:he cere-

In infancy
ɔre marked
deeper and
ɜxtensive in
le thinking.
.e greater is

net-work so close that the finest needle can not
pierce
some o:
Like
set goin
returnir
the two
fibers u
as a sing
Nerv
kinds of
scope th
and the
much gr
are foun
The

27.—The
olution
upper

sponding to the heart in the circulation, is the brain. It occupies the whole cavity of the head, and is carefully protected from injury by the skull. The front and upper part of the brain, about seven eighths of

Fig. 28.—Upper surface of the cerebrum, showing the convolutions of the brain and its double structure.

the whole, is called the *cerebrum;* the back and lower portion, the *cerebellum.*

The interior mass of the brain is composed of white matter, but the entire surface has a thin covering of gray. The surface of the cerebrum is made up of irregular rounded ridges, or *convolutions*, giving to it a large amount of surface.* In the cere-

* The convolutions of no two brains are exactly alike. In infancy they are scarcely visible, but they deepen and become more marked with age. In the civilized races the brain convolutions are deeper and much more numerous than in savages. They are also more extensive in a studious and thoughtful person than in one who does little thinking. The greater the number and depth of the convolutions, the greater is

bellum the ridges are parallel and less rounded. A deep indentation extending from front to back di-

FIG. 29.—The cerebrum, the cerebellum, the spinal cord, and the general distribution of the nerves.

vides the brain into parts, so that in reality the brain is double, corresponding to the pairs of the external

the amount of brain-surface, and the greater the amount of gray matter which covers the surface. It is therefore supposed that the gray matter increases with study and thought, and with any active business which depends upon thinking and demands intelligent control.

It is estimated that in some of the most perfect human brains there are nearly eight hundred square inches of surface.

portions of the body. From the nervous mass within the skull twelve pairs of *cranial nerves* extend to different parts of the head and face.

The Spinal Cord.—From the brain the *spinal cord*, the great center of nerve-distribution, extends downward through the spinal column to the lower extremity of the trunk. An enlarged part of this cord, which lies next to the cerebellum and extends below it, is called the *medulla oblongata*. Thirty-one pairs of nerves issue from the spinal cord and extend to the different parts of the trunk and the limbs. These are called *spinal nerves*.

The Ganglions.—Each of the nerves sent out from the spinal cord is in two parts, one coming out of an opening on the back side of the spinal column, and the other from a similar opening in front. These parts soon unite and form a single nerve, and at their point of meeting is a little bunch of nervous matter called a *ganglion*. These ganglions form a row on each side of the spinal cord; but, as each lies in the course of a single nerve, they have no direct communication with each other.

Sympathetic System.—Another row of ganglions lies on each side of the spinal column deeper down. They are connected throughout their whole extent, and form an important center of nervous force. From this center, nerves extend to the heart, the lungs, and the other vital organs. Small threads of nervous matter serve to unite these ganglions to the nerves that issue from the spinal cord.

Use of the Nerves.—As we have seen, each nerve issues from the spinal cord in two parts;

and, though these parts unite and form a single thread, each part has a distinct function. The section which issues from the back part of the spinal cord carries to the brain impressions derived from objects, and is called the *sensory nerve;* the one that issues from the front part carries orders from the brain to the muscles so as to direct motion, and is called the *motor nerve.*

For example, the naked toe comes in contact with a live coal. A message is immediately sent along the sensory nerve to the brain, telling the mind that the toe is burning. The mind at once telegraphs back along the motor nerve to the proper muscle an order to draw the toe away from its dangerous position. The muscle obeys, and the toe is saved.

Direct Nerve-Action.—When the mind gives a command to a muscle, the message starts from the brain, and we are conscious both of the order given and of the act performed. This is called *direct nerve-action.* To perform this direct action, the mind must be informed, or intelligent, in regard to the matter in hand. It must have a clear purpose, and must issue a clear command.*

Reflex Action.—Movements of the vital organs, over which the mind has no control, are constantly

* When a pupil is intent on the study of a subject, and takes all possible pains to understand it, the mind controls every step, the nerve-action is direct, and both the brain and the mind grow. When he is engaged in learning and reciting the words of a text-book, with little or no attention to the thought, the mind is only half conscious, the nerve-action is almost automatic, and neither the brain nor the mind is benefited.

going on, and there are many movements of the external organs which are automatic, or unconscious. Such movements have their origin, not in the brain, but in the other nervous centers, principally in the ganglions and the spinal cord. This unconscious movement is called *reflex action.*

Reflex action has control of the vital organs, so that the processes of life go on without the action of the will. The mind has no direct control over the action of the heart, the liver, or any other of the vital organs. Were vital action under the control of the will, the mind might sometimes forget, and then life would cease. Reflex action has also general care of the body when the brain is at rest and the mind is asleep.*

Sympathetic Action.—While the lower nervous centers control general vital action, the second system of ganglions has a peculiar function. This ganglionic system, as a nervous center, sends nerves

* Breathing is partly under the control of the will. We can suspend our breath for a brief time, but soon the motion of breathing will be resumed in spite of the will. A case is on record of a man who could by an effort of his will control the beating of the heart. He tried the experiment of stopping his heart "once too often," and it never began again.

The care of the body during sleep is shown when the hand brushes away a fly that lights on the nose, but does not waken the mind.

Coughing is caused by spasms of reflex action operating upon the muscles in the lungs. When a bit of food gets into the trachea, the cough-spasm throws it out. Diseases of the lungs produce the same feelings as the presence of foreign substances, and hence lung-diseases are accompanied by coughing. *Sneezing* is a similar spasm produced by foreign substances or disease in the nose. The *hiccough* is a nervous spasm of the diaphragm, caused by exhaustion, as from excessive laughter. or from the effect of alcohol.

to all the vital organs, and these organs are thus placed in direct communication and sympathy with one another. This nervous connection is called the *sympathetic system.* When the stomach is out of order, the sympathetic nerve gives notice, and the heart and lungs sympathize and become deranged in action. Disturbance in one organ is felt in all the others.*

Habit and Training.—In every action which comes from thought, the mind, through the brain, directs the first steps. When the actions are repeated a sufficient number of times, the muscles become accustomed to the movement, and the act is performed with ease. When this is the case, the direction of such acts is given over to the lower nervous centers, and the actions are performed with little or no consciousness.

The name given to this unconscious repetition of an action is *habit.*† The precision and rapidity

* This sympathy gives rise to many needless fears. A person eats too much, and the stomach labors hard to get rid of the oppressive load. In sympathy with this effort, the beat of the heart becomes feeble and irregular. Then the terrible fear comes that the heart is diseased, and that death is near. The doctor comes, laughs at the fears, gives a little mustard, and the patient is well the next day.

The use of tobacco produces "heart-burn," a trouble of the stomach, and this in turn, through sympathetic action, causes palpitation of the heart.

† Habits once formed are difficult to overcome. Habits formed in youth are the most lasting. The old man is slovenly because as a boy he was untidy. The fine scholar can not in his oration entirely get rid of the inelegant expressions of his childhood. The cruel boy becomes the brutal man.

Good habits are equally durable. The kindly acts of the boy or the girl ripen into kindness in the man or the woman. When effort to do things well becomes a fixed habit, it makes life rich in well-doing.

of action which come from habit constitute *skill;* and the method by which skill is obtained is *training.** The training which converts acts into habits relieves the mind and the brain, and leaves them free to study new things and to perform new acts.

Exercise of the Nerves.—Like the other parts of the body, the nerves require exercise. The food furnishes the elements of nerve-growth, but exercise is necessary to make their growth vigorous and to secure strength. When the mind is engaged in observing objects, finding out their qualities, and comparing them with other objects, it is giving direct exercise to the sensory nerves. When the hands are doing something under the direction of the mind, the motor nerves are brought into exercise. In both these cases, and in all thinking, the brain is exercised.

If nerve-exercise is omitted, the whole body suffers, the vital organs are feeble in their action, the blood moves slowly in the veins and the arteries, waste is imperfectly made up, the muscles become flabby and weak, and the brain is so little nourished that at last it becomes incapable of vigorous action. The starved mind, working through the starved brain, gradually loses the vitality it had at first, until it becomes little better than idiotic. To prevent this

* A young lady beginning to play the piano is obliged to fix her whole attention upon the position of her hands and upon the keys she is to strike. When training has given her skill, she strikes the keys correctly without thinking, and she is able to give her whole attention to the music. In like manner, skill enables the workman to do his best work with the least conscious attention.

result, the mind requires daily activity in careful study, or in directing some useful work.*

Rest of the Nerves.—The nerves also need rest. Like the muscles, they become tired with exercise. Nightly sleep furnishes the necessary rest for proper daily exercise. If, during the day, the nerves are unduly exercised or strained, they become weary, and sleep does not restore their vigor. If the strain is continued, sleep is broken, the weariness increases, and the nervous system breaks down, leaving the person a helpless burden to others. Excessive study, or excessive work of any kind, which requires brain-labor, often results in congestion or softening of the brain, or in paralysis.

How Alcohol affects the Nerves.—Alcohol and other narcotics have a tendency to paralyze the nerves, and so diminish their power to act. This effect first shows itself in the nerves which control the passage of the blood through the small arteries. The half-torpid nerves can not sufficiently control the rush of the blood, and the minute vessels are gorged. This gives to the skin a peculiar redness, which is very observable in the delicate skin of the face. The brain is affected in a similar manner, and is gorged with blood, causing great

* The nerves are greatly affected by emotion. By a joyous and happy mood nervous action is increased, the vital organs are stimulated to do their work well, and a glow of health pervades the whole body. Grief diminishes nervous action. Sudden bad news sometimes so paralyzes the nerves that the heart ceases for a time to beat, and faintness, or even death, is the result. Ill temper, envy, sulkiness, and all kinds of selfishness and meanness, diminish nerve-force, and tend to derange the action of the vital organs.

activity and tumult, but not the orderly action which produces good thinking and leads to useful doing.

If the alcohol is continued until the habit of drinking is formed, the derangement of the nerves becomes more marked. The heart is weakened and grows feeble in its action; the nerves lose control of the muscles and the limbs stagger; and there is a general derangement of all the organs, because the nerves which ought to produce harmony of action are paralyzed.

Effect on the Mind.—The cerebrum is the seat of intelligence and of the moral nature. Through the cerebrum the mind directs and controls bodily action. The cerebellum is the seat of the nervous influence that more immediately affects the body, and it controls the regular order of unconscious action, like walking. Alcohol much more quickly paralyzes the cerebrum than the cerebellum. In consequence, when drink has been taken in excessive quantities, both the intelligence and the moral nature are dead for a time, and the appetites and passions have full sway. In this way a man is often converted into a brute, dangerous to his family, to his neighbors, and to himself. Continued drunkenness often ends in delirium and death.

How Tobacco affects the Nerves.—The general use of tobacco diminishes nervous action. Its habitual use is not so destructive as that of alcohol, but still it is a substance which enters into the system without furnishing any needed element. It is in the body, but not of it. When used to excess, it

has a particularly paralyzing effect upon the nerves which control the muscles of the heart, weakening its action to such a degree as often to cause spasms and insensibility.

Inheritance.—Children inherit from their parents nerves weakened by the use of alcohol and tobacco, and the lives of thousands of innocent persons are thus made miserable. Usually the first drink and the first smoke are found to be very disagreeable, but quite often an inherited appetite shows itself, and the sweet breath of the child becomes foul with the whisky and tobacco which can not be kept out of his way. Beginning with this unnatural appetite, habits are speedily formed which make his life a burden to himself and to others.

Hygiene of the Nerves.

As the nerves control all the movements of the body, both conscious and unconscious, and thus affect its nourishment, we need to take the greatest care to keep them healthy, and especially to avoid all courses likely to injure them.

I. We must observe all the laws of digestion, so that the brain and the nerves may be supplied with pure blood.

II. We must avoid breathing foul air, or the nerves will be paralyzed by the impurities of the blood.

III. To keep it in health, the brain should every day be brought into vigorous action by some form of study or thinking.

IV. Active daily exercise, by either work or

play, is necessary to secure the healthful action of the nerves distributed through the body.

V. We need a great variety of objects to observe, to handle, and to study, in order that the sensory nerves may receive sufficient exercise.

VI. We need a great variety of work, having the stimulus of a useful purpose, that the motor nerves and the brain may be excited to healthful action.

VII. When we are tired we need rest, because as much nervous force as we can spare has been used up. Sleep, the natural rest from daily toil, should be regular, and should continue until the vigor of the nerves is restored.

VIII. The hardest study and the closest thinking should be done when the nerves are most vigorous, and that is usually during the first half of the day.

IX. We should never try to think or study when we are sleepy. In the first place, we then need sleep more than knowledge; and, in the second place, we gain very little knowledge when the mind is weary.

X. We should avoid continued and excessive mental work, because it may become so exhausting as to break down the whole nervous system.

XI. When the nerves have become so exhausted that we can not sleep, we must give up all labor and thinking until the nerves have recovered their lost strength.

XII. Cramming for an examination is much more exhausting than a much longer period of regular study, and should be avoided.

XIII. We should try to do those things which will form good habits, so that we may easily and certainly perform good deeds throughout life.

XIV. We should take special pains to avoid doing anything which tends to form bad habits, because it will be always difficult, and sometimes impossible, to correct such habits when they have once been formed.

Something to Find Out.

1. In study, what should always be our object?
2. In the study of science, what evils come from trying to learn the exact words of a text-book?
3. What is the effect of adding careful experiment to the study of a subject?
4. In case we do not understand a subject that we have studied, what is to be done?
5. Why is it injurious to attempt to hold the breath for any considerable time?
6. When we have eaten too much, what symptoms, besides sickness at the stomach, may we expect?
7. After we have learned to walk, what nervous action controls walking?
8. What trouble would come if the cerebrum were obliged to control walking?
9. Why is it easier to perform an act the second time than at first?
10. What is the result of doing one act repeatedly?
11. When we perform acts without much thinking, what have we acquired?

12. What kinds of acts lead to the formation of good habits? of evil habits?

13. What does a person need in order to become a good base-ball player?

14. What term is applied to persons who do not like to exercise either body or mind?

15. What good do we get from play that we do not get from work?

16. What good results from work that does not come from play?

17. Why is night the best time for sleep?

18. What good comes from having sleep at regular hours?

19. Why should we give up study when we are sleepy?

20. What kind of games are beneficial to students while attending school?

21. What kind of games would rather injure than benefit them?

22. Explain how a game may be beneficial to a farmer when it would injure a student.

23. What class of people is most benefited by a week's fishing in summer?

24. What good comes from the use of alcohol when we are in health? From the use of tobacco?

25. How does alcohol affect speech?

26. Why may a drunken man be considered insane?

27. In what way can we best avoid the dangers and miseries which come from drunkenness?

28. How may we escape from the danger of heart-trouble caused by tobacco?

CHAPTER X.

HOW THE MIND GETS IDEAS AND EXPRESSES THEM.

Sensations.—The sensory nerves receive impressions from objects and carry them to the brain. These impressions are called *sensations*. When the sensation is fully known to the mind, it is called an *idea*. Since the skin most directly comes in contact with objects, it has the greatest supply of sensory nerves. From nerves in the muscles we get ideas of pressure and weight. Through the nerves of touch in the skin we get from the surface of objects the ideas which are expressed by the terms hard and soft, rough and smooth, hot and cold.

But these ideas are not enough. The mind needs to know about flavors and odors; it must get from sound its meaning and its music; and from light it must learn the beauty of form and color. For these purposes some of the sensory nerves take the form of special nerves of sense, as those of taste, smell, hearing, and sight.

The Sense of Taste.

The Taste as a Sentinel.—Special care must be taken that improper food be not admitted into the

stomach. The mind must keep close watch over all things eaten, and must reject such as will be likely to injure any part of the body. One of the agents which the mind uses to determine whether food is wholesome or unwholesome is the sense of taste.

Flavors.—When food is taken into the mouth, it gives an impression which we call *flavor*.* The nerves upon which flavors make an impression give us the sense of taste, and are called *gustatory* nerves. They are distributed over the tongue and the back part of the mouth. Many substances taken in the mouth may be felt but not tasted. *Touch* takes notice of certain qualities of all substances; but *taste* notices flavors only, and is not aroused to activity until the surface of the substance yielding the flavor is dissolved by saliva. We can get no idea of flavor except through the gustatory nerves.

Before flavors can be perceived, the substance must come in direct contact with the nerve. When a strong flavor has been tasted, the impression will remain for some time, and will prevent other flavors from making their proper impression. Except in disease, the flavor of most wholesome foods is pleas-

* The primary and strongest flavors are sweetness, sourness, saltness, and bitterness. Besides these, there are the flavors peculiar to different fruits, such as peaches, grapes, etc., and the flavors peculiar to the different varieties of the same fruit, as that of Catawba and of Delaware grapes. It is thought by some that all possible flavors are made up of different combinations of the four primary ones; but this point is not settled.

ant, and the necessary act of daily eating is thus rendered agreeable.*

The Sense of Smell.

Odors.—Another of the agents employed to test foods is the sense of *smell.* When certain substances are brought near the nose, they make an impression which is called *odor.* The nerves upon which odors make an impression give us the sense of smell, and are called *olfactory* nerves.† These nerves are distributed through the cavities of the nostrils. Substances smelled do not come in contact with the olfactory nerve. Such substances give off something that we call *aroma,* or odor. In no way can we measure or weigh odor. It is only known through the sense of smell. Agreeable odors give us a sense of pleasure, and also stimulate the whole nervous system.

* The sense of taste is not a perfect guide in the choice of foods. One of the conditions of good digestion is that food shall be palatable. But palatable food is not always wholesome, and the mind must have other means of deciding what shall be eaten.

The act of eating is agreeable; but, if we give ourselves up to the pleasures of the appetite, swine have an advantage over us, as they appear to enjoy eating even better than we do.

† The olfactory nerve notices nothing but odors. Unpleasant odors denote the presence of something hurtful. Food that is tainted, or that gives off an unpleasant odor, is unfit for the human stomach. Air that smells vile is unfit to breathe. A keen sense of smell is very desirable, and it will be well to always "follow the nose" when it leads away from bad odors.

The Sense of Hearing.

Sound.—Whenever an object of any kind moves, a portion of the air is disturbed and set in motion. Whenever an object has a continued motion to and fro, a similar wave-like motion, or *vibration*, is set up in the air. These vibrations strike upon the ear, and produce an impression which is called *sound*.* The nerves that receive impressions of sound are the *auditory* nerves, and the sense that has sound for its object is the sense of *hearing*.

It is necessary that the mind should know what movements are going on around it, so that it may avoid danger, and take advantage of circumstances to carry out its purposes. It should be able to distinguish different sounds for the pleasure that music affords. The mind must also be able to distinguish and produce the sounds used in articulate speech for the purpose of understanding and of expressing thought. These ends it accomplishes by means of the ear.

The Ear.—The ear, which is the organ of hearing, has three parts: the outside or external ear,

* The least number of vibrations that produce a sound which the ear can perceive is sixteen per second. As the vibrations increase in rapidity, the sound becomes higher in pitch. The highest sound that the ear perceives is made by about thirty-two thousand vibrations per second. Vibrations below sixteen and above thirty-two thousand per second are silent to the human ear.

The sense of hearing may be cultivated so that the ear will detect sounds which are not audible to other ears, and will observe differences which were before unnoticed. This cultivation makes life richer by the new enjoyments which it affords.

which we see; the middle ear, or *tympanum*, which is a small passage through the bones; and the in-

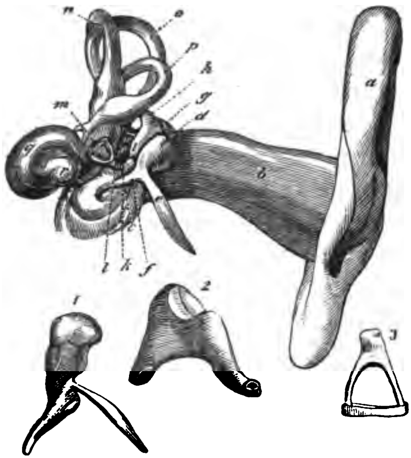

FIG. 30.—The parts of the ear: *a*, external ear; *b*, passage; *c*, membrane of the tympanum; *d—m*, bones and their connections; *n—r*, interior canals and openings; 1, 2, 3, small bones of the ear, highly magnified.

ternal ear, which consists of several winding passages in the bony structure of the skull. The three parts of the ear are separated by thin membranes which stretch across each end of the tympanum like the head of a drum. A passage, called the *Eustachian tube*, opens from the tympanum into the throat.*

The vibrations of the air striking the outer mem-

* Through the Eustachian tube, air is admitted to the inside of the tympanum, so that the pressure upon both sides of the "ear-drum" is equal. When we have a cold and the throat is swollen, the mouth of this tube is closed, and we become quite deaf for a time. The remedy is, not to doctor the ears, but to cure the throat.

brane of the tympanum cause it to vibrate, and the motion is conveyed to the auditory nerve, which is spread over the passages of the internal ear. This gives the impression of sound. The quality and intensity of the vibrations are in some measure regulated by a chain of minute bones within the tympanum, and by the limpid fluid which fills all the passages of the internal ear. The auditory nerve notices nothing but sound.

Care of the Ear.—The ear needs little care except to be kept clean; otherwise it should be let alone. The wax which lines the inner passage is bitter, and prevents insects from crawling in.* It should not be removed. In summer, boys, while in swimming, often get water into their ears. It frequently remains for a considerable time, and is very disagreeable. This difficulty may be prevented by stuffing a little cotton into the ears before going into the water.

The Sense of Seeing.

Light.—It is now generally believed that light, as well as sound, is produced by vibrations. But while sound comes from vibrations of the air, light is the result of vibrations of a fluid much thinner than air, and which fills all the space between the earth, the sun, and the stars. These vibrations make no impression upon any of the nerves of the

* In spite of all care, an insect sometimes gets into the ear, where its movements sound exceedingly loud. When this happens, oil may be used to destroy the life of the intruder, and then the ear may be cleansed by means of a soft cloth.

body except the *optic* nerve of the eye, and here it gives the impression which is called light.*

Need of Light.—The mind needs to know the forms and positions of objects. The body, in traveling in search of food, must avoid the abrupt precipice, the dangerous pit, the deep water. It must have some sure guide to the things necessary to its existence. The mind must be able to judge of distance for purposes of use and protection. It also has higher needs. For its own growth and happiness it must be able to see the beauty which color unfolds, and which is found in the shifting scenes of mountain and sea, and in the varying forms of animal and vegetable life. All these come to the mind by means of light and through the eye.

The Eye.—The eyes are spherical bodies about one inch in diameter, and are placed in bony sockets in the front part of the skull. On all sides, except the front, they are protected by strong bones and cushions of soft tissue. The eyelids, with rows of eyelashes along their edges, can close over the front of the eyes, so as to protect them from dust and insects. The eyebrows turn the sweat on the forehead away from the eyes. Tears keep the eyes moist, and winking spreads the tears over their surface.†

* By means of a prism it is shown that light is composed of many colors. Differences in color are supposed to come from difference in the rapidity of the vibrations which produce light.

† A tube connects the tear-gland with the nose, so that extra tears usually flow through it. In case of great grief, or anger, the tears overflow, and this excess of tears is called *weeping*. Sometimes the tube leading to the nose gets obstructed, producing what is termed a "weeping eye."

Structure.—The eye has three coats. The *sclerotic* coat, on the outside, is strong and tough. It serves to keep the eye in shape, and also as a place

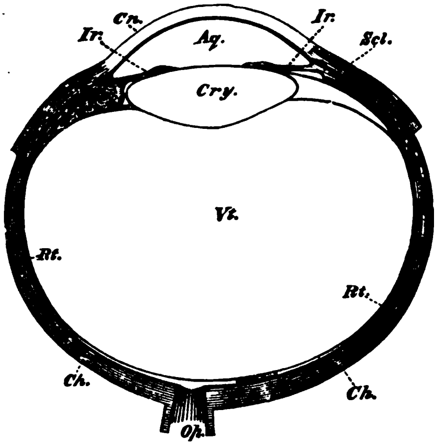

FIG. 31.—Horizontal section of the eyeball: *Scl*, sclerotic coat; *Cn*, cornea; *Ch*, choroid; *Ir*, iris; *Aq*, aqueous humor; *Cry*, crystalline lens; *Vt*, vitreous humor; *Rt*, retina; *Op*, optic nerve.

of attachment for muscles. This coat has an opening in front, in which a convex transparent membrane called the *cornea* is placed, very much as a crystal is inserted in a watch. Next, inside, is the *choroid* coat, made of softer tissue, and containing the blood-vessels that supply the eye. The interior part of this coat is black or very dark-colored.* The *retina*, or inside coat, is formed by the spread-

* The dark interior surface of the choroid coat absorbs the light which is not needed for clearness of seeing. When this black coloring-matter is wanting, as in the case of albinos, vision is defective.

ing out of the optic nerve over the back part of the eye.

The *crystalline lens* is a transparent body, shaped like a convex eye-glass, only much thicker in the middle. It lies near the front of the eye, encircled by the sclerotic coat. The space back of the crystalline lens is filled with a transparent, jelly-like substance called the *vitreous humor;* and the space between the crystalline lens and the cornea is filled with a watery fluid called the *aqueous humor.* In front of the crystalline lens is a colored curtain called the *iris.* Through the iris is an opening called the *pupil*, through which light is admitted. The muscles of the iris are so constructed that in a dim light they enlarge the pupil so as to admit more light, and in strong light they diminish the pupil so that some of the light is shut out.*

Muscles of the Eye.—Muscles in the interior of the eye change the form and position of the crystalline lens, and enlarge and diminish the iris for the purpose of adjusting the light. The motion of the whole eye is controlled by four straight muscles which move it up and down, and from right to left. Besides these, one muscle goes through a pulley, and rolls the eye around in its socket.†

* The effect of light upon the iris may be seen by observing the eyes of a cat. In a strong light the pupil closes so nearly that it appears only as a faint line. In a dim light the pupil enlarges so much that the iris nearly disappears.

† When the interior muscles are too strong, the eyes are turned toward the nose, producing *internal strabismus*, or "cross-eyes." When the exterior muscles are too strong, *exterior strabismus* results. These difficulties can be easily remedied by a skillful surgeon.

Action of Light.—The light enters the eye through the cornea, and passes through the aqueous humor. The iris here steps in and shuts off all light not needed. The crystalline lens next receives the light that the iris permits to pass, and so adjusts itself that the light falls upon the retina in just the way to make the right impression of form. When vision is perfect, an exact image of the object seen is made upon the retina.*

Care of the Eye.—The crystalline lens is sometimes too convex, producing short-sightedness. This trouble calls for the use of concave glasses. As old age comes on, the crystalline lens becomes flattened, and convex glasses are needed. When we read or study, the light should be thrown upon the book or object, and not into the eyes. A glare of light in the eyes makes objects appear dim. On the other hand, we should avoid trying to read or see small objects in a dim light. If the strain which such a practice occasions is continued, it is liable to weaken the eyes and produce temporary or permanent blindness. Cross-lights, or lights coming into a room at different angles, are hurtful to the eye. As these lights are of different intensity, the muscles of the iris become weary of trying properly to adjust the ever-changing light.

* Get from the butcher the eye of an ox; carefully cut away the sclerotic coat on the back side; then darken a room, except one ray of light. In this opening place the eye, as though looking out. On the retina can then be seen a distinct image of objects outside, but they appear upside down. From the same eye may be obtained an idea of the brilliancy and transparency of the vitreous humor.

The Organs of Speech.

The mind has need to express thought as well as to receive it. It needs not only to learn from the experience of others, but also to give to others the result of its own experience. The most effective means by which this interchange of ideas is brought about is the voice as heard in *speech*. Certain combinations of sounds are called words, and words express ideas.

The Voice. — The *larynx* is the prominence which lies immediately above the trachea. The triangular opening from the mouth into the larynx is called the *glottis*. Along each side of the glottis are thin membranes called *vocal cords*. These membranes usually hang loose, but they can be stretched and made to vibrate. They then produce sound in much the same way as it is produced by the vibrating strings of a musical instrument. This sound is the *voice*.

Speech.—The sounds of the voice will be higher or lower as the vocal cords are more or less tightened, and so vibrate faster or slower. By slight changes in the opening of the glottis the sound can also be made to vary in quality and quantity. The voice, coming out through the mouth, is shaped into articulate speech by the teeth, tongue, palate, roof of mouth, and lips, under the direction of the mind.*

* Speech is chiefly a matter of imitation. Children who are accustomed to hear correct speech will usually speak correctly. During the first three or four years of school-life, distinctness of speech may be promoted by giving rather more than the usual prominence to the syllables

Care of the Voice.—Scarcely anything is more to be desired than a pleasant voice. The possessor of such a voice is sure to be heard when no heed is given to others, and his presence gives pleasure where that of others would give pain. To secure the possession of these pleasant tones, care must be taken not to put too great a strain upon the vocal cords in youth. Screaming, loud wrangling, boisterous singing, and hallooing, all have a tendency to break or harden the vocal cords, so that afterward they can make none but coarse and harsh tones. Care must also be taken not to use the vocal cords much when the throat is sore from any cause.

Hygiene of the Organs of Special Sense.

I. When things taste bad, we should examine them with great care, and know that they are not harmful before we eat them.

II. We should be careful not to injure the sense of taste by the use of tobacco and other pungent substances.

III. Things that smell bad should be avoided.

IV. It is well to refresh ourselves and to stimulate our nerves by a very moderate use of perfumery.

V. Keep all hard instruments out of the ear-passages.

VI. Do not sit facing the light.

VII. Do not use the eyes much in a dim light.

VIII. Do not try to study or look closely with cross-lights or other uncertain and varying lights.

of words. Later the same object may be gained by short daily drills upon the vocal elements of the language.

IX. Do not attempt to see much when the eyes give notice of exhaustion by sleepiness or pain.

X. Do not strain the vocal cords by continued loud and high tones in singing or in speech.

XI. Use the voice gently at the period when it is "changing," and always when there is any inflammation of the throat.

Something to Find Out.

1. What part of the skin is best supplied with sensory nerves, and is therefore the most sensitive?
2. What can we find out by the sense of touch?
3. Why does a piece of marble feel cooler than a piece of fur that lies by its side?
4. Does it ever happen that the marble feels warmer than the fur under the same conditions?
5. Why can we not taste a piece of marble?
6. How can we tell the flavor of a fruit that we have heard described but have never seen?
7. What old fable shows the folly of deciding upon the flavor of grapes that grow out of reach?
8. Why can we not relish the flavor of a peach just after taking quinine?
9. What difference does the gustatory nerve perceive between the surface of a piece of iron and that of a piece of soft, cotton cloth?
10. Why should we take considerable time for each of our meals?
11. Why should we not usually spend several hours at a meal?
12. Why are roses and lilacs so frequently planted about houses?

13. What would be the effect, if fragrant flowers could be planted around all homes?

14. Why should we object to having a tannery or a slaughter-house put up near our dwelling?

15. In what way can we turn to profitable account the decaying vegetable and animal substances which give off bad odors?

16. Why should we cultivate a liking for pleasant odors, and learn to discriminate between them?

17. What animals are noted for keenness of scent? Of what use is this sense to them?

18. What are some of the disadvantages of being deaf?

19. What pleasures of a high character do we get through the ear?

20. What special charms has an early morning walk in the country in summer?

21. When near by, why is the shrill whistle of a locomotive or the clang of a gong disagreeable?

22. Read from Goldsmith's "Deserted Village" the description of summer evening sounds. What sounds are described, and why do they all make so pleasant an impression?

23. What advantage has the cultivated musician over one who has no taste for music?

24. What difference in shape do you notice between the pupil of a cat's eye and that of your own?

25. What differences do you notice in the iris of the eyes of different persons?

26. What in other parts of the body correspond

to the coloring of the iris, and the black coloring-matter of the interior of the eye?

27. What is the color of the eyes of an albino, and why is his sight defective?

28. What are some of the useful ideas which we get through the eye?

29. What pleasurable emotions come from traveling among the mountains?

30. What from observing the sea? What from a walk in the garden?

31. How does voice differ from speech?

32. What are some of the disadvantages of a harsh voice?

33. What does a pleasant voice indicate?

34. Why should not little children be permitted to sing "at the top of their voices"?

35. What advantage comes from always hearing clear and pleasant tones in speech?

CHAPTER XI.

STIMULANTS AND NARCOTICS.

1. Stimulants.

Unnecessary.—Continuous exercise without intermission is impossible. Even the heart, which seems always busy, rests more than it works. It reposes and feeds between its beats. Its resting spells are short, but they come often. They occupy three fifths of the time, so that in twenty-five hours the heart works but ten and reposes fifteen.

When muscular or mental exercise is too violent or prolonged, fatigue is felt. The waste of muscular or brain substance is greater than the repair. Food and rest relieve the fatigue.

The repairing materials are supplied by the food; they are used during rest.

The food should be sufficient but not excessive in quantity; nutritious, easily digestible, and varied in quality. The time devoted to eating and repose should be ample. It should not be stinted nor begrudged as if it were misspent.

When the various parts of the body are in a healthy condition, only food and rest are required to enable them to exercise their functions to the best advantage.

In disease there may be emergencies when stimulants are useful and necessary. Like the helping hand extended to an exhausted swimmer, they may save from fatal sinking. Like the whip which is vigorously applied to the overtasked and straining street-car horses, when they falter near the summit of the hill, stimulants may impart an artificial strength which shall be sufficient to overcome the difficulty. But stimulants are goads. They do not nourish. They add nothing to the material from which permanent strength is derived. In health they are useless. The horse which can do its customary work only while under the constant application of the lash is really disabled by laziness or disease. And the person who resorts to alcoholic stimulants because he thinks that without their frequent goading he can not perform the drudgeries, or even the ordinary duties of life, is in a pitiable condition. If he be in health he is mistaken.

Observation proves that, in the long run, more and better mental and physical work can be done; hunger, fatigue, and long exposure to extreme cold or heat better endured; and that the average health approaches more nearly a perfect standard without than with the habitual use of stimulants.

Injurious.—But stimulants are injurious. Like the too powerful mainspring in a delicate watch, they produce strong and violent manifestations, but they wear out the works.

The tendency of alcoholic stimulants—and these are the only ones now under consideration—is to impair the normal action of the various parts of the

body, and even to produce serious organic disease. How this is accomplished is explained in various parts of this book.

One of the saddest results of the use of these stimulants is a diseased craving, which can be satisfied only by the further use of that which caused the craving and which intensifies it.

Daily observation and abundant testimony prove that this acquired appetite may, and in numberless instances does, become almost irresistible, requiring increasing potations to appease its insatiable demands, and dragging down its helpless victims, through disease and loss of self-respect and blunted moral perceptions, and even crime, to utter ruin.

If alcoholic stimulants are unnecessary, injurious, and dangerous, should they not be avoided? Is not the path of safety the path of wisdom?*

2. *Narcotics.*

These are substances which first exhilarate and then induce drowsiness or stupor. There are many of them, but two only will be noticed here: opium and tobacco.

* As showing how the habit of using alcoholic beverages diminishes the likelihood of recovery from serious illness, the following statement is of great value. It is from the report of the Investigation Committee appointed by the British Medical Association. The report was published in July, 1884.

In 1,065 cases of pneumonia there were 192 deaths.

The mortality of the temperate was 17 per cent.; of the intemperate, nearly 43 per cent.; while of the total abstainers it was but 10 per cent.

The consumption of opium and its various preparations has greatly increased within a few years. While its continuous use does not seem to shorten materially the life of its devotees, it renders it miserable. It enfeebles the intellect, enervates the bodily powers, and gives a dull and vacant appearance to the face. Habitual opium-eating always weakens and perverts the moral sense. From its firm grasp its victims seldom escape. Their brief struggles for release become more and more impotent, till finally the captivity is accepted as hopeless. Opium should be taken only when administered by a wise and prudent physician.

Tobacco affects primarily the nervous system. It stimulates and it soothes. It seems to furnish great pleasure to those who chew or smoke it. But it has its drawbacks. Its habitual use impairs digestion, often causes palpitation of the heart, trembling of the hands, disturbance of the delicate bronchial tissue, and sometimes permanent injury of the nerves.

Chewing is specially filthy. Smoking is offensive to a large proportion of the best people.

Those who have abandoned the use of tobacco declare that they have sweeter breath, cleaner tongues, better digestion, steadier nerves, increased power of endurance, and a higher average of enjoyment; and that the loss of the fascinating excitement is more than offset by freedom from the resulting depression.

Should not a practice, however popular, which is filthy, offensive, hurtful, and expensive, be avoided?

WHAT THE WORDS MEAN.

Ab-do'men (Latin, *abdo*, to hide). The largest cavity of the body, situated beneath the level of the diaphragm, and containing the liver, stomach, intestines, etc.; the belly.

Ab-sor'bents (Latin, *ab* and *sorbeo*, to suck up). The vessels which take part in the process of absorption.

Ab-sorp'tion. The process of sucking up fluids by means of an animal membrane.

Ac'id (Latin, *acidus*, from *acere*, to be sour). A substance usually sour, sharp, or biting to the taste.

Ad'am's Ap'ple. An angular projection of cartilage in the front of the neck. It is particularly prominent in males, and is so called from a notion that it was caused by the apple sticking in the throat of our first parent.

Al-bi'no (Italian, *albino*, whitish). A person having a peculiar whiteness of the skin and hair, and a redness of the iris and pupil of the eye.

Al-bu'men (Latin, *albus*, white). An organic substance resembling white of egg.

Al-bu'mi-noids (Latin, *albumen*, and Greek, *eidos*, form). A class of substances resembling albumen; they may be derived from either the animal or the vegetable kingdom.

Al'co-hol (Arabic, *al kohl*, a powder to paint the eyebrows with). The intoxicating element of spirituous liquors.

Al-i-ment'a-ry Ca-nal' (Latin, *alimentarius*, from *alo*, to nourish). A long tube, of varying form and size in its different parts, in which the digestion of the food, or "aliment," is performed. It comprises the mouth, the pharynx, the esophagus, the stomach, and the small and large intestine.

Al'ka-li (Arabic, *al kali*, the soda-plant). A name given to certain substances, such as soda, potash, and the like, which have the power of combining with acids to form salts.

A-nat'o-my (Greek, *anatome*, cutting up, dissection). The study of the different parts and the structure of the body.

Am'y-loid (Greek, *amulon*, fine meal, and *eiaos*, form). A substance similar to *amyle*, which is composed of ten parts of carbon and eleven of hydrogen.

A-or'ta (Greek, *aorteomai*, to be lifted up). The largest artery of the body, and main trunk of all the arteries. It arises from the left ventricle of the heart. The name was first applied to the two large branches of the trachea, which appear to be lifted up by the heart.

Ap-pend'age (Latin, *ad*, to, and *pendeo*, to hang). Something added to a principal or greater thing.

A'que-ous Hu'mor (Latin, *aqua*, water). A few drops of watery, colorless fluid occupying the space between the cornea and crystalline lens.

A-ro'ma (Latin). The agreeable odor of plants or other substances.

Ar-te'ri-al Blood. The bright-red blood in the left side of the heart and the arteries of the general circulation.

Ar'ter-y (Greek, *aer*, air, and *tereo*, to keep). A vessel conveying the blood from the heart outward to the organs; so called because the ancients thought these vessels contained air.

Ar-tic-u-la'tion (Latin, *articulo*, to form a joint). The movable union of bones; a joint.

Ath-let'ic (Greek, *athleo*, to contend for a prize). Belonging to wrestling, boxing, running, and other manly exercises and sports.

Au'di-to-ry Nerve (Latin, *audio*, to hear). The special nerve of the sense of hearing.

Au'ri-cle (Latin, *auricula*, the outer ear). The smaller and thinner chamber of the heart on each side, which receives the blood directly from the veins; so called from a fancied resemblance in shape to a dog's ear.

Au-to-mat'ic (Greek, *automatos*, self-moving). Self-acting; not depending on the will.

Bi'ceps (Latin). A muscle situated upon the front part of the arm above the elbow, which serves to bend the elbow-joint.

Bi-cus'pid (Latin, *bi*, two, and *cuspis*, prominence). The name of the fourth and fifth teeth on each side of the jaw; possessing two prominences.

Bile. The gall, or peculiar secretion of the liver; a sticky, yellowish fluid, and very bitter to the taste.

Blonde. Of a fair, or light, color or complexion.

Bone. A firm, hard substance, of a white or pale-rose color, composing the skeleton or firmer part of the body.

Brain. The mass of nervous substance contained in the cavity of the skull.

Bron'chi (Greek, *bronchos*, the windpipe). The two larger branches into which the trachea is divided, and into which the *bronchial tubes* open.

Bron'chi-al Tubes. The smaller branches of the trachea within the substance of the lungs, ending in the air-cells.

Bru-nette'. Of a brown or dark color or complexion.

Ca-lis-then'ics (Greek, *kalos*, beautiful, and *sthenos*, strength). The practice of healthful exercise of the body and limbs, to give strength and grace of movement.

Cal'lus (Latin, *calleo*, to be thick-skinned). Any excessive hardness of the skin, caused by friction or pressure.

Ca-nal' (Latin, *canna*, a pipe). In the body, any tube or passage.

Ca-nine' Teeth (Latin, *canis*, a dog). The pointed teeth situated just outside the incisors, one on each side in each jaw; so called because they are very prominent in the dog, as well as in other flesh-eating animals.

Cap'il-la-ries (Latin, *capillus*, hair). The smallest blood-vessels, between the arteries and the veins; so called from their minute or hair-like size.

Car-bon'ic Ac'id (Latin, *carbo*, coal). The gas which is present in the air expelled from the lungs; a waste product of the animal kingdom, and a food of the vegetable kingdom.

Car'di-a (Greek, *kardia*, heart). The upper opening of the stomach, through which the food enters from the esophagus; so called because it is situated near the heart.

Car'di-ac. Pertaining to the heart or to the cardia

Car'ri-on (Latin, *caro*, flesh). The dead and decaying bodies of animals.

Car'ti-lage (Latin, *cartilago*). A firm, elastic substance, like India-rubber, attached to the bones in various parts of the body, forming a part of the joints, air-passages, nostrils, and ear.

Cav'i-ty (Latin, *cavus*, hollow). A hollow, inclosed space.

Ca'se-ine (Latin, *caseus*, cheese). The albuminoid substance of milk, forming the basis of cheese.

Cer-e-bel'lum (Latin, diminutive of *cerebrum*, brain). The little brain, situated at the back and lower part of the head.

Cer'e-brum (Latin). The brain proper, occupying the entire upper portion of the skull. It is nearly divided into two equal parts, called hemispheres, by a cleft extending backward from the front part of the head.

Chest. The upper part of the trunk of the body, inclosed by the spinal column behind, the ribs on the sides, and the breast-bone in front.

Cho'roid (Greek, *chorion*, skin, and *eidos*, like). A brownish-black membrane forming the middle coat of the eye-ball.

Chyle (Greek, *chulos*, juice). Chyme changed in the duodenum, and turned white by the emulsion of fats.

Chyme (Greek, *chumos*, juice). The pulpy liquid formed by digestion within the stomach.

Cir-cu-la'tion (Latin, *circulus*, a ring). The circuit or course of the blood through the blood-vessels of the body, from the heart to the arteries, through the capillaries into the veins, and from the veins back to the heart.

Clav'i-cle (Latin, *clavis*, a key). A slender bone, shaped somewhat like a key, placed horizontally at the bottom of the neck, between the top of the breast-bone and the point of the shoulder. The collar-bone.

Col'lar-Bone. The clavicle.

Con'cave (Latin, *concavus*, hollow). Curved or rounded, like the inside surface of a hollow globe.

Con-ges'tion (Latin, *con*, together, and *gero*, to bring). An unnatural gathering of blood in any part of the body.

Con-nect'ive Tis'sue. A tissue consisting of loose fibrous bundles, which is placed between the muscles and other parts.

Con-sump'tion (Latin, *consumo*, to take entirely). A disease of the lungs, attended with a fever and cough, and causing a gradual decay of the bodily powers.

Con-trac'tion (Latin, *con*, together, and *traho*, to draw). The active shortening of a muscle or muscular fiber.

Con'vex (Latin, *conveho*, to bring together). Curved or rounded, like the outside of a globe.

Con-vo-lu'tions (Latin, *convolvo*, to roll together). The foldings of the external surface of the brain.

Cor'ne-a (Latin, *cornu*, a horn). The transparent, horn-like substance

which covers the front part of the eyeball, through which the light passes.

Crys'tal-line Lens (Latin, *crystallum*, ice). A transparent, circular body, rounded on its front and back surfaces, situated in the eyeball, just behind the pupil.

Cus'pid (Latin, *cuspis*, a point). A pointed tooth next back of the incisors.

Cu'ti-cle (Latin, diminutive of *cutis*, the skin). The scarf-skin; also called the *epidermis*.

Cu'tis Ve'ra (Latin). The true skin, lying beneath the cuticle; also called the *derma*.

Dan'druff. The small scales, or particles, which separate from the scarf-skin of the scalp.

De-lir'i-um (Latin). A state in which the ideas of a person are wild, irregular, and unconnected.

Den'tine (Latin, *dens*, a tooth). The bony or ivory-like part of the teeth, lying directly beneath the enamel.

Der'ma (Greek, the skin). The soft, moist, and thick underlying layer of the skin; the *true skin*, or *cutis vera*.

Di'a-phragm (Greek, *diaphragma*, a partition). The muscular sheet which separates the cavity of the chest from that of the abdomen.

Di-ges'tion (Latin, *di*, apart, and *gero*, to bear). The preparation of the food in the alimentary canal.

Dig'i-ti-grade (Latin, *digitus*, finger, and *gradi*, to walk). An animal that walks or steps on its toes.

Dis-ease'. An unhealthy condition of some part of the body.

Duct (Latin, *duco*, to lead). A narrow tube, usually designed to convey away a secretion from the gland in which it is produced.

Du-o-de'num (Latin, *duodeni*, twelve each). The first division of the small intestines, about twelve finger-breadths long.

E-las-tic'i-ty. The property of bodies by which they recover their former figure or size after the removal of outside pressure or force.

En-am'el. The dense material which covers the crown of the tooth.

Ep-i-der'mis (Greek, *epi*, upon, and *derma*, skin). The outer layer of the skin; the scarf-skin, or cuticle.

Ep-i-glot'tis (Greek, *epi*, upon, and *glottis*). A leaf-shaped piece of cartilage which covers the top of the larynx during the act of swallowing.

E-soph'a-gus (Greek, *oiso*, to carry, and *phago*, to eat). The tube

leading from the throat to the stomach, through which the food and drink pass in eating.

Ex-cre'tion (Latin, *excerno*, to purge out). The process by which the waste materials of the body are removed; also the materials excreted.

Ex'er-cise (Latin, *exerceo*, to keep busy). Effort or action of the body for the sake of training, or of keeping its organs and functions in a healthy state.

Ex-pan'sion (Latin, *ex*, out of, and *pando*, to open). The act of extending or spreading out.

Ex-pi-ra'tion (Latin, *expiro*, to breathe out). The act of forcing air out of the lungs.

Ex-ten'sor (Latin, *ex*, out, and *tendo*, to stretch). A muscle which serves to straighten or extend a joint.

Eu-sta'chi-an Tube. A membranous canal, extending from the fore part of the tympanum of the ear to the side of the pharynx; from Eustachi, an Italian anatomist.

Fe'mur (Latin). The thigh-bone.

Fi'ber (Latin, *fibra*, a thread). One of the string-like portions which constitute a part of the tissues of plants and animals.

Fi'bril (diminutive of fiber). A very small branch of a fiber.

Fi'brine (Latin, *fibra*, a fiber). An animal matter found in the blood; so called because, when clotted, it has a fibrous texture.

Fib'u-la (Latin, that which serves to fasten two things together). The outer and smaller bone of the leg.

Flex'or (Latin, *flecto*, *flexum*, to bend). A muscle which serves to bend a limb or joint.

Flip'per. The broad fin of a fish.

Fol'li-cle (Latin, diminutive of *follis*, a bag). A little pouch or depression in a membrane; it has generally a secretory function.

Func'tion (Latin, *fungor*, *functus*, to perform). The office performed by any organ of the body.

Gan'gli-on (Greek, *ganglion*, a knot). A knot-like swelling in the course of a nerve; a smaller nerve-center.

Gas'tric (Greek, *gaster*, the stomach). Pertaining to the stomach.

Gel'a-tine (Latin, *gelo*, to congeal). An animal substance which dissolves in hot water, and forms a jelly on cooling.

Gland (Latin, *glans*, an acorn). An organ consisting of follicles and ducts, with numerous blood-vessels; it separates some particular fluid from the blood.

Glot'tis (Greek, *glotta*, the tongue). The narrow opening between the vocal cords in the upper part of the larynx, by which it communicates with the throat.

Glu'ten (Latin). Literally, glue; the gluey, albuminous matter of wheat-flour.

Gus'ta-to-ry Nerve (Latin, *gusto*, to taste). The nerve of taste supplying the front part of the tongue.

Gym-nas'tics (Greek, *gumnazo*, to exercise). The practice of athletic exercises.

Hic'cough. A spasm of some of the muscles used in breathing, accompanied by a shutting of the glottis and a sudden sound.

Hu'me-rus (Latin). The large bone of the arm between the shoulder and the elbow.

Hu'mor (Latin). Moisture: the humors are transparent contents of the eyeball.

Hy'gi-ene (Greek, *huygieia*, health). The art of preserving health and preventing disease.

I-de'a (Greek, outward appearance). The complete conception of an object.

In-ci'sor (Latin, *incido*, to cut). Applied to the four front teeth of both jaws, which have sharp, cutting edges.

In-den-ta'tion (Latin, *in*, and *dens*, a tooth). A notch in the margin of anything.

In-fe'ri-or Ve'na Ca'va (Latin, lower hollow vein). The chief vein of the lower part of the body.

In-flam-ma'tion (Latin, prefix *in*, and *flammo*, to flame). A peculiar diseased condition of any part of an animal body.

In-gre'di-ent (Latin, *ingredi*, to go into). That which enters into a compound as one of its constituents.

In-spi-ra'tion (Latin, *in*, and *spiro*, *spiratum*, to breathe). The act of drawing in the breath.

In-ter-cos'tal Mus'cles (Latin, *inter*, between, and *costa*, a rib). The muscles which are situated between the ribs, and which move the ribs in respiration.

In-tes'ti-nal Juice. A sticky secretion produced by the lining membrane of the small intestine.

In-tes'tine (Latin, *intus*, within). The part of the alimentary canal which is continuous with the lower end of the stomach; also called the bowels.

I'ris (Latin, *iris*, the rainbow). The thin muscular ring which lies be-

tween the cornea and crystalline lens, and which gives the eye its brown, blue, or other color.

Jaun'dice (French, *jaune*, yellow). A disease in which the skin assumes a yellowish color, supposed to be caused by an excess of bile.

Lac'te-als (Latin, *lac*, *lactis*, milk). The absorbent vessels of the small intestines ; during digestion they are filled with chyle, which has a milky appearance.

Lar'ynx (Greek). The box of cartilage situated at the top of the windpipe, through which the air passes from the throat into the trachea ; the organ of the voice.

Lens (Latin). Literally, a lentil ; a piece of transparent glass or other substance so shaped as either to bring together or disperse the rays of light.

Lig'a-ment (Latin, *ligo*, to bind). A fibrous band or cord, serving to attach two bones to one another.

Liv'er. The largest gland in the body, reddish in color, situated mainly on the right side, below the diaphragm. From the venous blood passing through it, it secretes bile. The liver produces from the blood an animal starch.

Lobe. A round, projecting part of an organ, as of the liver, lungs, or brain.

Loin. That part of an animal just above the hip-bone.

Lu'bri-cate. To make smooth or slippery.

Lung. One of the two organs of respiration in an air-breathing animal.

Lymph (Latin, *lympha*, spring-water). The colorless, watery fluid conveyed by the lymphatic vessels.

Lym-phat'ic Ves'sels. A set of very thin, delicate vessels, which absorb the lymph from the tissues of the body, and convey it inward toward the center of the venous system.

Mac-a-ro'ni (Greek, *makar*, blessed). An article of food, composed chiefly of wheat-flour made into long, slender tubes, and much used in Italy.

Mar'row. The soft, fatty substance contained in the central cavities of the bones : the spinal marrow, however, is composed of nervous tissue.

Mas'se-ter (Greek, *massaomai*, to chew). A strong muscle situated upon the side of the face, which moves the lower jaw from below upward in chewing.

Mas-ti-ca'tion (Latin, *mastico*, to chew). The act of cutting and grinding the food to pieces by means of the teeth.

Me-dul'la Ob-lon-ga'ta (Latin). The "oblong marrow," or nervous cord, which is continuous with the spinal cord within the skull.

Mem'brane (Latin, *membrum*, a limb or member). A thin layer of tissue serving to cover some part of the body.

Mi'cro-scope (Greek, *mikros*, small, and *skopeo*, to look at). An optical instrument which magnifies objects.

Mo'lar (Latin, *mola*, a mill). The name applied to the three back teeth of each side of the jaw, which are adapted for grinding the food, like millstones.

Mo'tor (Latin, *moveo*, *motum*, to move). Causing motion ; the name of those nerves which conduct to the muscles the stimulus which causes them to contract.

Mu'cous Mem'brane. The thin layer of tissue which covers those internal cavities or passages which communicate with the external air.

Mu'cus (Latin). The sticky fluid which is secreted by mucous membranes, and which serves to keep them in a moist condition.

Mu-ri-at'ic Ac'id. An acid consisting of one part of hydrogen and one of chlorine.

Mus'cles (Latin, *musculus*, a little mouse). A band of fibers acting as an organ of motion in animal bodies. The *voluntary* muscles act in obedience to the will, and contract suddenly ; the *involuntary* muscles do not obey the will, and contract slowly.

Nar-cot'ic (Greek, *narkao*, to benumb). A medicine which, in poisonous doses, produces stupor, convulsions, and sometimes death.

Na'sal (Latin, *nasus*, the nose). Pertaining to the nose ; the *nasal cavities* contain the special nerve of smell.

Nerve (Greek, *neuron*, a cord or string). A glistening, white cord, shaped like a tube, and connecting the brain or spinal cord with some other organ of the body. The nerves are the telegraph-wires of the body.

Nerve-Fi'ber. A very slender thread of nervous tissue found in the nerves ; it is of a white color.

Nos'tril (Anglo-Saxon, *nosu*, nose, and *thyrl*, a hole). One of the two outer openings of the nose.

Nurt'ure. To train up with care ; the food and attention necessary to such training.

Nu-tri'tion (Latin, *nutrio*, to nourish). The processes by which the nourishment of the body is accomplished.

Ol-fac'to-ry (Latin, *olfacio*, to smell). Pertaining to the sense of smell.

O'pi-um. A narcotic drug obtained from the juice of the white poppy.

Op'tic (Greek, *opto*, to see). Pertaining to the sense of sight.

Or'gan (Greek, *organon*, an instrument). Any part of the body which is adapted to perform a particular service, such as the heart, the stomach, the brain.

Ox'y-gen (Greek, *oxus*, sharp, and *genein*, to bring forth). A gas forming one fifth part, by bulk, of the atmosphere, and essential to respiration.

Pal'ate (Latin, *palatum*, the palate). The roof of the mouth, consisting of the hard and soft palate.

Pan'cre-as (Greek, *pas*, *pantos*, all, and *kreas*, flesh). A long, flat gland placed behind the stomach; in the lower animals this organ is called the *sweet-bread.*

Pan-cre-at'ic Juice. The secretion produced by the pancreas.

Pa-pil'læ (Latin, plural of *papilla*). The minute elevations in which terminate the fibers of the nerves of touch and taste.

Pa-ral'y-sis (Greek, *paraluo*, to loosen). A disease of the nervous system marked by the loss of sensation, or voluntary motion, or both ; palsy.

Pa-tel'la (Latin, diminutive of *patina*, a pan). The knee-pan.

Pel'vis (Latin, a basin). The bony cavity at the lower part of the trunk ; the hip-bone.

Per-i-car'di-um (Greek, *peri*, about, and *kardia*, heart). The sac inclosing the heart.

Per-i-os'te-um (Greek, *peri*, around, and *osteon*, a bone). A fibrous membrane surrounding the bones.

Per-spi-ra'tion (Latin, *perspiro*, to breathe through). The sweat, or watery fluid poured out from the skin ; when visible, it is called *sensible* perspiration ; when invisible, *insensible* perspiration.

Phar'ynx (Greek, *pharunx*, the throat). The muscular passage leading from the back part of the mouth to the esophagus.

Phys-i-ol'o-gy (Greek, *phusis*, nature, and *logos*, a discourse). The science of the functions of living, organized beings ; the study of the natural actions of the living body.

Pig'ment (Latin, *pingo*, to paint). Coloring-matter.

Plant'i-grade (Latin, *planta*, the sole of the foot, and *gradi*, to walk). An animal that walks on the sole of the foot, as the bear.

Pleu'ra (Greek, a rib). A membrane covering the lung and lining the chest. There is one for each lung.

Pneu-mo'nia (Greek, *pneuma*, air, and *pneo*, to breathe). An inflammation affecting the air-cells of the lungs.

Por'tal Vein (Latin, *porta*, a gateway). The venous trunk formed by the union of all the veins coming from the intestine. It conveys the blood to the liver.

Proc'ess (Latin, *procedo*, *processus*, to proceed, to go forth). Any projection from a surface. Also, a method of doing anything.

Pro'te-id (Greek, *protos*, first, and *eidos*, form). An element allied to nitrogen; a substance containing such elements; an albuminoid.

Pul'mo-na-ry (Latin, *pulmo*, *pulmonis*, the lungs). Pertaining to the lungs.

Pulse (Latin, *pello*, *pulsum*, to beat). The striking of an artery against the finger, occasioned by the contraction of the heart, commonly felt at the wrist.

Pun'gent (Latin, *pungo*, to prick). Sharply painful or biting.

Pu'pil (Latin, *pupilla*). The central, round opening in the iris, through which light passes into the depths of the eye.

Py-lo'rus (Greek, *puloros*, a gate-keeper). The lower opening of the stomach, through which the food passes into the intestine; so called on account of a circular band of muscular fibers by which the passage is guarded.

Qui'nine (Spanish, *quina*, Peruvian bark). An extract of Peruvian bark used to cure fever, and give vigor to the system.

Ra'di-us (Latin, a spoke of a wheel). The bone on the thumb-side of the fore-arm.

Re'flex Ac'tion. An involuntary action of the nervous system, by which an external impression conducted by a sensory nerve is reflected, or changed into a motor impulse.

Res-pi-ra'tion (Latin, *re*, denoting repetition, and *spiro*, to breathe). The function of breathing, comprising two acts: *inspiration*, or breathing in, and *expiration*, or breathing out.

Ret'i-na (Latin, *rete*, a net). The membranous expansion of the optic nerve in the interior of the eyeball, which receives the impressions resulting in the sense of vision.

Rib. One of the long bones inclosing the cavity of the chest. In man there are twelve on each side. The upper seven are called *true ribs;*

the other five are the *false ribs*, of which the last two are called *floating ribs*.

Sa-li'va (Latin). The moisture or fluids of the mouth, secreted by the salivary glands.

Sal'i-va-ry Gland. A gland which produces saliva.

Sar-to'ri-us (Latin, *sartor*, a tailor). The muscle which throws one leg across the other.

Scalp (Latin, *scalpo*, to cut). The part of the skin of the head usually covered with hair. It is the part cut off by Indian warriors as a token of victory over an enemy.

Scap'u-la. The shoulder-blade.

Scarf-Skin. The outer layer of the skin ; the *cuticle*, or *epidermis*.

Scle-rot'ic (Greek, *skleros*, hard). The tough, fibrous outer coat of the eyeball.

Se-ba'ce-ous (Latin, *sebum*, fat). Resembling fat ; the name of the oily secretion by which the skin is kept flexible and soft.

Se-cre'tion (Latin, *secerno*, *secretum*, to separate). The process of separating from the blood some important fluid ; the fluid is also called a secretion.

Sen-sa'tion (Latin, *sensus*, sense). The conscious perception of an external impression by the nervous system ; a function of the brain.

Sen'so-ry Nerve (Latin, *sentio*, to perceive). A nerve of sense.

Se'rum (Latin, whey, buttermilk). The clear, watery fluid which separates from the clot of the blood. It contains, besides water, albumen and mineral substances.

Shaft. A long, slender body, like a stem or stalk.

Shoul'der-Blade. The flat, triangular bone of the shoulder ; the *scapula*.

Skel'e-ton (Greek, a dried body). The bony frame-work of an animal, the different parts of which are kept in their proper relative positions.

Skull (a shell or bone). The bony case which incloses the brain.

Sock'et (Latin, *soccus*, a kind of low-heeled shoe). An opening into which anything is fitted.

Spasm (Greek, *spasmos*, convulsion). A sudden, violent, and involuntary contraction of one or more muscles or muscular fibers.

Spe'cial Sense. A sense by which we receive particular sensations, differing from those of general sensibility ; such as those of sight, hearing, taste, and smell.

Spe-cif'ic Grav'i-ty. The ratio of the weight of a body to the weight of an equal bulk of some other body, usually water, taken as the standard.

Spher'i-cal (Latin, *sphera*, a globe). Having the form of a sphere.

Spi'nal Col'umn. The connected vertebræ of the back; the backbone; the spine.

Spi'nal Cord. A cylinder-shaped mass of nervous matter situated in the cavity of the spinal column.

Spine (Latin, *spina*, a thorn). A projecting point or ridge of bone.

Spleen. An organ largely made up of small vessels, and situated within the abdomen, near the left extremity of the stomach.

Ster'num (Greek, *sternon*, the breast). A flat, rectangular bone, extending vertically along the middle of the chest, to which the seven upper ribs are attached.

Stim'u-lant (Latin, *stimulo*, to prick or goad on). An agent which causes an increase of vital activity in the body or any of its parts.

Stri'a-ted (Latin, *strio*, to furnish with channels). Marked with fine parallel lines.

Sub-cla'vi-an Vein (Latin, *sub*, under, and *clavis*, a key). The great vein bringing back the blood from the arm and side of the head; so called because it is situated underneath the *clavicle*, or collar-bone.

Su-pe'ri-or Ve'na Ca'va (Latin, upper hollow vein). The great vein of the upper part of the body.

Sur'ger-y. That branch of medical science which treats of manual operations for the healing of diseases or bodily injuries.

Sut'ure (Latin, *suo*, to sew or stitch). The seam or joint which unites the bones of the skull.

Sym-pa-thet'ic Sys'tem of Nerves. A double chain of nervous ganglions connected together by numerous small nerves, situated chiefly in front of and on each side of the spinal column.

Symp'tom (Greek, *sum*, with, and *pipto*, to fall). A sign or token of disease.

Sys-tem'ic. Belonging to the system, or body, as a whole.

Tar'tar. A hard crust which forms on the teeth, and is composed of salivary mucus, animal matter, and a compound of lime.

Tem'ple (Latin, *tempus*, time, and *tempora*, the temples). The part of the head between the ear and the forehead; so called because the hair begins to turn white with age in that portion of the scalp.

Ten'don (Latin, *tendo*, to stretch). The white, fibrous cord or band by which a muscle is attached to a bone; a sinew.

Text'ure (Latin, *texo*, to weave). The particular arrangement of tissues that form an organ.

Tho-rac'ic Duct (Greek, *thorax*, the chest). A narrow tube running from below upward within the back part of the chest, which is the main trunk of the lymphatic vessels.

Tho'rax (Greek, *thorax*, a breast-plate). The upper cavity of the trunk of the body, containing the lungs, heart, etc.; the chest.

Tib'i-a. The principal bone of the leg below the knee.

Tis'sue. Any substance or texture in the body formed of various elements, such as cells, fibers, blood-vessels, etc., interwoven with each other.

To-bac'co (Indian, *tabaco*, the tube or pipe in which the Indians smoked the plant). A plant used for smoking and chewing and in snuff. It has a strong smell and a pungent taste.

Tra'che-a (Greek, *trachus*, rough). The windpipe, or the largest of the air-passages; composed in part of rings of cartilage, which render its surface rough and uneven.

Trans-par'ent (Latin, *trans*, through, and *pareo*, to appear). Capable of allowing light to pass through. Transparent bodies can be seen through.

Tri'ceps (Latin, *tria*, three, and *caput*, head). The large muscle which straightens the arm, or that which extends the leg.

True Skin. The inner layer of the skin; the *cutis vera*, or *derma*.

Trunk. The body, apart from the limbs.

Tym'pa-num (Greek, *tumpanon*, a drum). The cavity of the middle ear, resembling a drum in being closed by two membranes, and in having communication with the atmosphere.

Ul'na (Latin, the elbow). The bone of the fore-arm on the little-finger side.

Var'i-cose (Latin, *varix*, a dilated vein). Unnaturally enlarged—applied only to veins.

Vein. A vessel serving to convey the blood from the various organs inward to the heart.

Ve'nous (Latin, *vena*, a vein). Pertaining to, or contained within, a vein.

Ven-ti-la'tion (Latin, *ventus*, wind). The introduction of fresh air into a room or building in such a manner as to keep the air within it in a pure condition.

Ven'tri-cle (Latin, *ventriculus*, a little stomach). The larger and thicker chamber of the heart, on each side, which receives the

blood from the corresponding auricle, and discharges it into the artery.

Ver'te-bra (Latin, *vertebra*, a joint). One of twenty-six separate bones, called vertebræ, firmly jointed together to form the spinal column.

Ver'te-brate. Having a backbone formed of vertebræ.

Vi-bra'tion (Latin, *vibro*, to move to and fro). Quick motion to and fro.

Vi-tal'i-ty (Latin, *vita*, life). The state or quality of being full of life.

Vit're-ous (Latin, *vitrum*, glass). Having the nature of glass.

Vo'cal Cords (Latin, *vox*, *vocis*, the voice). Two elastic bands or ridges situated in the larynx; they are the essential parts of the organs of the voice. Their vibrations, communicated to the air, produce the sound of the voice.

Vol'un-ta-ry (Latin, *voluntas*, will). Under control or direction of the will.

TOPICAL ANALYSIS.

CHAPTER I.—THE BODY AND ITS PARTS.

Why we should Study our Bodies.

1. The head, neck, trunk, and limbs seen.
2. The internal organs not seen.
3. To avoid injury of outward parts.
4. To care for organs within the body.
5. To secure health.
6. To improve looks.
7. To increase usefulness.

About Parts of the Body.

1. The arms.
2. The legs.
3. The joints: ball-and-socket—hinge—compound.
4. Parts in pairs.
5. Bodies of other animals.
6. Uses of parts of the body.
7. Intelligent care of the body.

Something to find out.

CHAPTER II.—Eating, and what comes of it.

Why we Eat.
1. The body always wearing out.
2. It needs repair.
3. We eat to live.
4. We eat to do the work we have to do.

What we Eat.
1. Different elements needed.
2. Food related to the industries.
3. Food related to geography.
4. Kinds of food.
   - Proteids: gluten—albumen—fibrine—caseine—gelatine.
   - Amyloids: starch—sugar—gums.
   - Fats: animal and vegetable oils.
   - Minerals: lime—soda—potash—iron—salt—water.
5. Special foods: vegetables—meats—fruits.
6. Value of different foods.
7. Ways of cooking.
8. Mixed foods necessary.

How we Eat.
1. Mastication.
2. The teeth: structure—names—uses.
3. Care of the teeth: necessity—implements.

How we Swallow.
1. How saliva flows—exciting causes.
2. Amount of saliva.
3. How saliva is wasted.
4. Tobacco: wastes saliva—vitiates saliva—defiles the breath.
5. The esophagus: structure—action.

Hygiene of mastication.
Something to find out.

CHAPTER III.—How Digestion goes on.

Stomach Digestion.

1. Structure of stomach.
2. Muscular action.
3. The gastric juice.
4. The absorbents.
5. Starchy foods changed to sugar by action of saliva.
6. Proteids dissolved by gastric juice.
7. Chyme.
8. Character and amount of drink.
9. Alcohol in the stomach:
    1. Stimulates action.
    2. Hardens mucous coat.
    3. Continued use inflames.
    4. Produces abnormal cravings.
10. Care of the stomach:
    1. Food properly prepared.
    2. Taken in proper quantities.
    3. Taken at proper times.

Intestinal Digestion.

1. The intestines: structure—juices—action.
2. The duodenum.
3. The pancreas: pancreatic juice—uses.
4. The liver: bile—nature—uses.
5. Alcohol in the liver:
    1. Stimulates action.
    2. Hardens tissue.
    3. Continued use inflames.
6. The absorbents: portal vein—liver.
7. The lacteals: chyle—the thoracic duct.
8. Summary of changes:
    1. Food masticated and mixed with saliva.
    2. Starch reduced by saliva and by action of pancreatic juice.
    3. Proteids reduced by gastric juice.
    4. Fats reduced by pancreatic juice and bile.
    5. Acids neutralized by the alkali of the bile.

Hygiene of digestion.
Something to find out.

CHAPTER IV.—How the Blood gets purified.

Movement of the Blood.
1. The heart: shape—position—covering.
2. The plan of the heart:
   1. The pulmonary heart.
   2. The systemic heart.
   3. The auricles, ventricles, and valves.
3. The pulmonary artery.
4. Pulmonary action:
   1. From vein to right auricle.
   2. From auricle to right ventricle.
   3. From ventricle to pulmonary artery.

Breathing.
1. The lungs: elastic tissue—the lobes—the pleura.
   1. Air-spaces: air-cells — bronchial tubes — trachea—larynx—glottis.
   2. Blood-flow: around air-cells — return in pulmonary veins.
2. The chest varies in capacity:
   1. By action of intercostal muscles.
   2. Movement of ribs and diaphragm.
3. Forces in breathing:
   1. The pressure of the air.
   2. The elastic force of the lungs.
4. Action in the lungs:
   1. Oxygen passes from air-cells into the blood.
   2. Impure matter from blood passes into the air-cells.

Alcohol in the Lungs.
1. Effort to expel alcohol with the breath.
2. Enfeebles the lungs.
3. Induces disease.
4. The blood imperfectly purified.

Tobacco in the Lungs.
1. Tobacco-fumes drawn into the lungs.
2. Retards lung-action.
3. Produces languor and stupidity.
4. Retards bodily growth.
5. Enfeebles the mind.

The Need of Pure Air. Ventilation.

Hygiene of respiration.
Something to find out.

CHAPTER V.—How the Blood nurtures the Body.

Waste and Repair.
1. Action wears out tissue.
2. The blood the agent of repair.

Channels of Circulation.
1. The arteries: structure—the aorta—branches.
2. The capillaries: size—extent.
3. The veins: structure—termination.

Action in the Heart.
1. From pulmonary vein to left auricle.
2. From auricle to left ventricle.
3. From ventricle to aorta.

Action in the Arteries.
1. Place of the arteries.
2. Jets of blood with each heart-beat.
3. Elasticity of the walls of the arteries.
4. The pulse, and what it indicates.

Action in the Capillaries.
1. Oxygen burns living tissue.
2. The burning causes heat and motion.
3. Worn-out particles are removed.
4. New particles are deposited.
5. The color of the blood is changed.

Action in the Veins.
1. The current flows evenly.
2. The valves open toward the heart.
3. Muscular action assists the blood-flow.
4. Varicose veins.

Alcohol in the Blood.
1. Does not become a part of the blood.
2. Causes red-blood corpuscles to shrink.
3. Deprives the blood of oxygen.
4. Interrupts combustion and repair.
5. Changes muscles of the heart into fat.
6. Gorges minute arteries with blood.

Hygiene of the circulation.
Something to find out.

CHAPTER VI.—How the Body moves.

Motion necessary.	1. The motion of the body and its parts indicates life. 2. Want of motion is the sign of death.
The Muscles.	1. The muscles produce motion and give beauty to the form. 2. General structure: connective tissue — swell muscles—hollow muscles—tendons—ligaments.
Muscular Action.	1. Contraction and expansion. 2. Voluntary and involuntary action. 3. Flexors and extensors.
Care of the Muscles.	1. Repair of muscles: 1. The blood supplies nourishment. 2. Muscles most exercised receive most nourishment. 2. Exercise of muscles: work—games—calisthenics. 3. Rest of muscles: after exercise—after injury. 4. Proper position: in sitting—in standing. 5. Dress must leave the muscles free. 6. Alcohol changes muscular fiber to fat. 7. Agreeable occupation lightens labor.
Exercise.	1. Exercise should be for health. 2. The body should serve the mind. 3. Muscular development not for display. 4. Muscles should not monopolize energies.

Hygiene of the muscles.
Something to find out.

CHAPTER VII.—How the Body is able to stand.

The Need of a Bodily Frame.	1. To stand erect. 2. To keep the body in proper form.
The Bones.	1. Uses of the bones: 1. To give shape to the body. 2. To protect delicate organs. 3. To afford attachment for muscles. 2. Forms of the bones. 3. Structure of the bones. 4. Materials: animal matter—mineral matter. 5. Growth and repair.
Distribution of the Bones.	1. Bones of the head: skull—sutures—face. 2. Bones of the trunk: pelvis—spinal column—ribs—breastbone—shoulder-blade—collar-bone. 3. Bones of the arm: humerus—ulna and radius—the wrist-bones—the hand. 4. Bones of the legs: femur—patella—tibia and fibula—ankle—foot—arch of the foot. 5. Bony cavities: skull—chest—pelvis.
Bodily Movements.	1. How produced. 2. How shocks are distributed.
Care of the Bones.	1. Proper food. 2. Suitable exercise. 3. Moderate exercise in childhood. 4. Proper positions. 5. Easy clothing. 6. Shoes of proper form and material. 7. Rest after injury.

Hygiene of the bones.
Something to find out.

CHAPTER VIII.—How the Body is covered.

Uses of Covering.
1. Protects internal organs.
2. Performs important functions.

Structure of the Skin.
1. Structure varies: callus—corns—nails—hair.
2. Layers of the skin:
    1. The scarf-skin: dandruff—pigment-cells—complexion.
    2. The true skin: papillæ—hair-follicles.
3. How the skin is kept soft: oil-tubes—sebaceous glands.

Function of the Skin.
1. Casting out waste: the sweat-glands—the kidneys.
2. Regulating heat: sensible and insensible perspiration.
3. How the skin absorbs.

Care of the Skin.
1. Cleanliness of the skin: necessity—bathing.
2. Temperature of the skin: clothing—artificial heat.

The Hair.
1. Uses of the hair:
    1. Protects from extreme heat and cold.
    2. Breaks the force of blows.
    3. Shields organs of sense from injury.
2. Structure of hair: the pith—the shaft—the root.
3. Health of the hair:
    1. Dependent on general health of the body.
    2. Necessity of cleanliness.
    3. Grayness and loss of hair.
    4. Effect of emotion.

Clothing.
1. Clothing protects and adorns.
2. It should be sufficient in quantity.
3. It should be suited to circumstances.
4. It should be clean and dry.
5. It should be easy.

Hygiene of the skin.
Something to find out.

CHAPTER IX.—How Bodily Motion is directed.

Direction necessary.
1. To produce harmony of action.
2. To nurture the body.
3. To execute plans.

Distribution of Nerves.
1. Resemblance to blood-vessels.
2. Extending from nerve-centers.
3. Reaching every part of the body.
4. In double sets.

Nerve-Matter.
1. Gray matter: cells.
2. White matter: threads.

Nerve-Centers.
1. The brain: cerebrum — cerebellum — convolutions — double structure — twelve pairs cranial nerves.
2. The spinal cord: the medulla oblongata—thirty-one pairs spinal nerves.
3. The ganglions: general—sympathetic.

Nerve-Function.
1. Sensory nerves conveying sensations.
2. Motor nerves controlling motion.

Nerve-Action.
1. Direct from brain.
2. Reflex from spinal cord.
3. Sympathetic from sympathetic ganglions.
4. Habit and training.

Care of the Nerves.
1. Exercise of the nerves.
2. Rest of the nerves: diversion—sleep.
3. Effect of emotion: joy—grief.

Effect of Alcohol.
1. Absorbs moisture from nerve-tissue.
2. Diminishes nerve-action.
3. Gorges the small arteries with blood.
4. Weakens the heart-action.
5. Leaves muscles without control.
6. Deranges the vital organs.
7. Paralyzes cerebral action.
8. Debases the higher nature.
9. Produces delirium.

Effect of Tobacco.
1. Diminishes nervous action.
2. Diminishes action of the heart.
3. Evil effects transmitted to children.

Hygiene of the nerves.
Something to find out.

CHAPTER X.—How the Mind gets Ideas and expresses them.

Use of the Special Senses.	1. To carry sensations to the mind. 2. To produce ideas in the mind.
The Sense of Taste.	1. Taste a sentinel guarding the stomach. 2. The gustatory nerve. 3. How flavors are perceived. 4. Palatable foods.
The Sense of Smell.	1. The olfactory nerve. 2. How odors are perceived. 3. Agreeable and disagreeable odors. 4. A guard to eating and breathing.
The Sense of Hearing.	1. Sound-vibrations: the auditory nerve—hearing. 2. The ear: external—middle—internal—Eustachian tube. 3. Care of the ear.
The Sense of Seeing.	1. Light-vibrations: the optic nerve—sight. 2. Need of light: 1. To protect the body from injury. 2. To observe beauty in the world. 3. The eye: form and position—structure—muscles. 4. Action of light: how regulated—produces vision. 5. Care of the eye: direction of light—use of glasses—intensity of light.
The Organs of Speech.	1. The need of expression. 2. The voice: the larynx—the glottis—the vocal cords. 3. Speech: pitch—quality—quantity—articulation. 4. Care of the voice—pleasant tones—avoid straining the voice.

Hygiene of the organs of special sense.
Something to find out.

BONES OF THE BODY.

THE HEAD—29 Bones.

Skull. (8 bones.)

- Front'al (*frontale*, frontlet—one in forehead).
- Pa-ri'e-tal (*paries*, wall—one on each side of head).
- Tem'po-ral (*tempus*, time—one in each temple).
- Sphe'noid (*sphenos*, wedge—one at base of skull, between temples and cheeks).
- Eth'moid (*ethmos*, sieve—one between cavity of skull and upper part of nose).
- Oc-cip'i-tal (*occiput*, back of head—one at base of skull).

Ears. (6 bones.)*

- Mal'le-us (mallet—outermost of chain, one in each ear).
- In'cus (anvil—middle of chain, one in each ear).
- Sta'pes (stirrup—innermost of chain, one in each ear).

Face. (14 bones.)†

- Lach'ry-mal (*lacryma*, tear—one in each orbit).
- Na'sal (*nasus*, nose—two, forming bridge of nose).
- Ma'lar (*mala*, cheek—one in each cheek).
- Tur'bi-nate (*turben*, whirl—one in outer wall of each nostril).
- Pal'a-tal (*palatum*, palate—two, completing skeleton of hard palate).
- Vo'mer (plowshare—separating nostrils).
- Su-pe'ri-or Max'il-la-ry (*superior maxilla*, upper jawbone—two, forming upper jaw).
- In-fe'ri-or Max'il-la-ry (*inferior*, lower—one in lower jaw).

Hy'oid (*v* and *eidos*, form, *u*-shaped—one in neck at base of tongue).

---

* In early life there is a fourth bone between the incus and the stapes in each ear, but later it becomes a part of the incus.

† As the teeth are developed from the mucous membrane, they are not usually looked upon as belonging to the skeleton. The temporary, or "milk," set contains eight incisors, four canines, and eight molars. The permanent set may be tabulated as follows:

Teeth. (32 in number.)

- In-ci'sors (*incido*, to cut—four in the front of each jaw).
- Ca-nines' (*canis*, dog—one on each side of each jaw, behind the incisors).
- Bi-cus'pids (*bi*, two, and *cuspis*, prominence—two on each side of each jaw behind the canines).
- Mo'lars (*mola*, mill—three on each side of each jaw, behind the bicuspids).

THE TRUNK*—57 Bones.

Spine. (24 bones.)	Cer'vi-cal Ver'te-bræ (*cervix*, neck—seven in the neck). Dor'sal Ver'te-bræ (*dorsum*, back—twelve in the back). Lum'bar Ver'te-bræ (*lumbus*, loin—five in the loins).
Shoulder. (4 bones.)	Scap'u-la (shoulder-blade—one on upper part of back on each side). Clav'i-cle (*clavis*, key—one on each side, between top of breastbone and point of shoulder).

Sternum (*sternon*, breast—one extending vertically along middle of chest).

Ribs. (24 bones.)	True (upper seven pairs attached to spine, and tied directly to breastbone by cartilages). False (lower five pairs attached to spine; three pairs tied to cartilages of preceding rib; two pairs "floating" unattached in front).
Pelvis. (4 bones.)	In-nom'-i-nate (*in*, not, and *nomino*, to name—two main bones of pelvis, forming hips). Sa'crum (sacred—one between innominate bones, formed of five consolidated vertebræ). Coc'cyx (cuckoo—one below sacrum, formed of four consolidated vertebræ).

THE LIMBS—120 Bones.

Upper. (60 bones.)†	Hu'me-rus (upper arm—one in each arm). Ul'na (elbow—one in each forearm, joined to the humerus). Ra'di-us (spoke—one in exterior of each forearm, moving around ulna). Car'pal (*carpus*, wrist—eight in each wrist). Met-a-car'pal (*meta*, beyond, *carpus*, wrist—five in each hand, between wrist and fingers). Pha-lan'ges (battalions—three in each finger, two in each thumb).

* Strictly, the scapula and the clavicle belong neither to the trunk nor the arms, but simply connect them. The sacrum and the coccyx may be classified as belonging to the spine.

† At the joints of the thumbs and great toes are pairs of small bones, eight in all, called sesamoid bones (*sesamon*, sesame-seed, and *eidos*, like).

Lower. (60 bones.)	Fe'mur (thigh-bone—one in each leg). Pa-tel'la (little pan—one covering each knee-joint). Tib'i-a (shin-bone—one in each leg, between knee and ankle). Fib'u-la (clasp—one bracing tibia in each leg). Tar'sal (*tarsus*, flat of foot—seven in each instep). Met-a-tar'sal (*meta*, beyond, and *tarsus*—five in each foot, between ankle and toes). Pha-lan'ges (battalions—two in each great-toe, three in each of the others).*

* The confusion about the number of bones in the body arises from counting them at different ages and omitting different sets. The following successive additions will explain the various numbers:

General bones of the skeleton	200
Bones of the ear in adults	6
	206
Additional bones in the ear in children	2
	208
The permanent teeth	32
	240
The sesamoid bones	8
	248

WHERE TO FIND THINGS.